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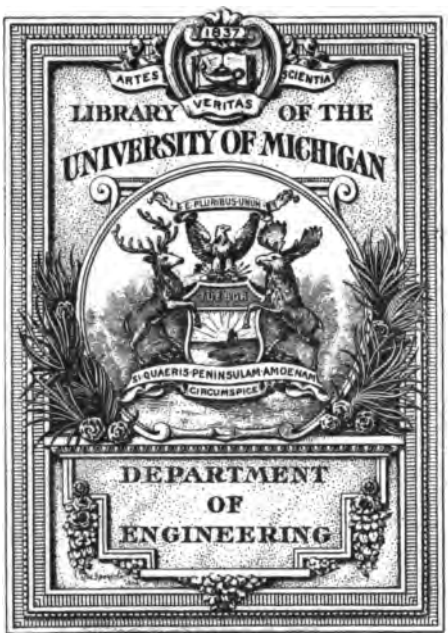
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ANNUAL CONVENTION, 1892.

MAYOR UHL'S ADDRESS.

The annual convention for 1892 was held in the city hall at Grand Rapids. Mayor Uhl welcomed the society to the city in a few well chosen words and continued as follows:

I ran upon some figures, gathered by the board of trade as to some of our manufacturing industries, and I see here that there is employed in capital $18,228,000, or was last year; that the value of the product was $33,555,000, as against $15,000,000 capital the year before, and $27,000,000 of product. The number of hands employed this year is 39,000 as against 13,000 the year before.

This city here, nestling in the valley of Grand river, was, but a few years ago, a hamlet surrounded by an agricultural country, but today it presents one industry that, as we think, takes the lead of all other cities in the land. It takes that lead for freshness of design and intelligence of workmanship, and while you are here gathering in your annual convention there is a great influx into this city, not only those who buy our wares, but those that come here, to the furniture center of the United States, bringing their wares to sell, and it will be as I have said, no doubt, the great privilege of the local members of your profession, before you shall go hence, to show you some of this manufactured product.

And now I bespeak for your annual gathering one of profit, one of pleasure and one of success. We tender to you, as I said in the beginning, the very best that we have, and as some one has said, the emphasis of hospitality lies in friendship, in cordiality, in attention, rather than in the externals or the accessories that surround it.

Time fails me, even were I competent, to speak of the noble profession which is yours. Would that while you are here you could show to us some way of preserving the beauty, the harmony, and the engaging grace that nature has given us in these hill-sides, and still accommodate it to the wants of man. Would that you could demonstrate to a certainty that it is the highest piece of vandalism to cut a canal through the beautiful park on the other side of the river in order that a few more loads of hay or a few more cords of wood may be brought upon West Fulton street.

Many of you are representatives of the class known as hydraulic engineers, and there is a subject which could engage the highest talent in that regard, for it has been a vexed question for many a year, a question that yet remains for solution, as to the permanent water supply of this city. That question is divided between the advocates of ground water, Grand river, Rogue river, Flat river, and I may say, Lake Michigan, and there are some who say, as far as that is concerned, except for culinary purposes, we don't need a great quantity of water in any event.

We are now taking our source of supply from the Grand river, and many of us are of opinion that if that source shall be taken three miles above where Rogue river empties into the Grand, that we shall have a satisfactory water supply.

I said a moment ago that time failed me, even were I competent, to speak of the excellencies and the glories and the beneficent results worked out by your exalted profession. We see today through its instrumentalities living results, which a decade ago we considered but the wild fictions of enthusiasts, and as unsubstantial as the stuff that dreams are made of.

Give me where to stand, said the ancient philosopher, and I will move the world. Find where to stand. Stand where you are, is the voice of science, and so your profession has done much—nay, has accomplished wonders beyond the power of tongue or pen to detail in the betterment of man, and in the building up of a civilization which today is in advance of all the ages that have gone before.

RESPONSE OF THE PRESIDENT, PROF. DAVIS.

Your honor, I suppose it falls on the president to thank you for your kind words of welcome. As I am only a sort of a president, but his representative, it falls upon me, I suppose, to say thank you, sir.

We men who live in bricks, and mud and mortar, you know are not usually talkers. That isn't a part of our business. Our business is to work. We came to Grand Rapids with the confident assurance, which needs no confirmation, of the same kind of a reception that we have met with, knowing that everything will be done for us that can be, and I spare words in that direction, to express some wishes I have.

I hope to see the day when the ships of the lakes shall make their wharves at Grand Rapids. I see no reason from what I have already learned, why that should not be done. I see no reason why you should not presently have a ten foot channel up to the city front.

It happens that acquaintances of mine and men that have formerly been in my employ, have been engaged in making a survey this summer for this purpose. I hope to see it accomplished. I have looked over the maps and plans some, and I see no reason why it may not be accomplished, and while I do not know the amount of water power you have here, I see no reason why seven or eight feet more may not be added to your present head, and perhaps that water power doubled, if you are prepared to utilize it.

As I came here the other day I saw what I suppose is your first ten story building. I see no reason why there should not be more. I see no reason why your city should not profit by every modern improvement. We who live in the State, take a pride in the city of Grand Rapids. It is, as you have truly said, the center of the furniture trade for this whole country, whole nation, and we look upon Grand Rapids as one of the features of Michigan—just as we count its other features—its wonderful, and simply matchless, system of inland navigation, yet to be improved as time passes, as we all know, and I take pleasure in referring to one particular item of that improvement which has fallen under my eye dur-

ing the past summer, which we will all take pleasure in hearing about, I think. The improvement of the St. Mary's river and the building of the new locks at the "Soo."

The opening of the St. Mary's channel will easily double the Lake Superior commerce, and that commerce now exceeds that of the Suez canal, as we all perhaps know. The St. Mary's river at the present time can be passed only in the day time. When the new channel is done, it can be passed continuously, day and night. The locks are already operated day and night by means of the electric light, so when that channel is done—'93 is the date set—in the fall—we may expect to double the capacity of that channel. It will be a 20-foot channel—indeed it is being made 21 feet. I know of no place where one can spend a few hours and receive more bona fide instruction than to sit on the canal docks of the Soo, and see the great vessels passing through there. Now a portion of that commerce must come up here. This city is entitled to it. It is only seven or eight miles to within grasp of that thing. All the fall of Grand River is in the first seven or eight miles and that can readily be overcome. While Grand Rapids extends to us, gentlemen, a most hearty welcome, I, in behalf of the Michigan Engineering society, wish to extend to the city of Grand Rapids, congratulations upon the prospect of being a sea-port in the literal and proper sense of the word. It cannot all be done at once. We know how these things are done. But I repeat, I see no reason why this city, with its wealth and possibilities, should not have a channel.

We shall take great pleasure, Mr. Mayor, in looking around your city. We come here to learn. I don't know whether I had better tell a story or not, but when I say we come here to learn, that word learn impresses me. Conceit, of all other things, is out of place it seems to me, amongst our class. I was once in the city of Philadelphia and called upon the Secretary of the National Society of Civil Engineers; he was good enough to mention my school work. He said, "I should remember your college. I have had some of your boys at work for me." I felt obliged to ask how they got along, even if I felt I was getting into a corner. He says, "There is one thing you do for your boys, you get the

conceit out of them." I said, "If you had studied to pay the school a compliment that I would appreciate, you could not have selected one that I would have thought more of." We as a profession, sir, will continue to learn as long as we are able. We come here to learn, to look around and see what you are doing, and whenever any of us have any municipal work on hand (I know I do and I understand that others do), we look to see, and ask what Grand Rapids has done in like cases, and we shall learn a great deal, and we shall use your welcome and I am sure we shall profit by it.

MAYOR UHL: Permit me to say one word in reply, and that is on the subject to which you have referred, viz.: the early improvement of the navigation of Grand river. It is a subject upon which the people of this city feel more deeply perhaps than any other. It is a railroad center, and our railroad facilities are extraordinary for a city of this size, and yet we feel, for the proper development of the city and its further growth, that this highway by water to the great lakes, should be and must be made.

And, sir, to hear you speak in terms so earnest and so thoughtful upon that subject which lies near the hearts of all the people of our city, is a matter of exceeding gratification, because we need aid in this enterprise—we need the aid of all the friends throughout the State, and perhaps in other states. As you, as president, have well remarked, this cannot be done at once, and we know that every enterprise of that kind has met with opposition, perhaps, and always obstacles, so it is a matter of great gratification to us that the people who come here and see the possible growth of this city, see its need of an outlet by way of the great lakes, and speak so earnestly and emphatically as you have done. I beg, sir, on behalf of this city, to thank you most cordially.

PROF. DAVIS: I cannot forbear one more word, if the mayor will pardon me for detaining him. But, putting the thing in a plain matter of fact way, here, we have said, is the great furniture center of the United States. Your timber line is further and further away. Your lumber has to be hauled in here by railroad to make this furniture. That timber line will recede year by year still further away, and it will be necessary

for you to seek timber in Wisconsin and on the shores of Lake Superior.

Now, shall we think of endangering a trade center of this character for the want of a ditch forty miles long, when we can dig dirt for seven cents a yard?

ADDRESS OF PRESIDENT DAVIS.

I believe it has been customary in times past for the convention to expect something from the president of these meetings, but that custom has been honored more, perhaps, in the breach than in the observance, certainly to the comfort and convenience of the members of the convention, and while I did not wish to detain Mayor Uhl to hear any remarks of mine, there are a few things that have been called to mind by his remarks, and my thoughts in connection, that I think will interest you, and if you will bear with me a few moments, I will refer to some of them.

These things I discovered while I was not a fishing. I spoke to you about the ship canal lock at the Soo and the St. Mary's river improvement. I have seen two or three things there, and heard of two or three more, of a good deal of interest to the profession. I was able to learn of a well boring device that some of you may be familiar with. This well boring device bored a four inch hole while exploring for the new lock 112 feet deep, for $3.50 per foot, in sandstone mostly, by means of a soft iron tube 24 inches long, with chilled iron shot, No. 12 to 14 under the edge of it, using a stream of water within the tube. The tube is turned on its axis, and these chilled shot are used under the edge of the tube, to make a cutting, down through the sandstone, leaving a core, which core is taken out in sections and brought out and laid on the floor. Perhaps you are all familiar with that method of boring. I was not.

It brought out a 3§ inch core. I saw this core and so inquired with regard to some of the practical facts connected with it. Too much shot stops the cutting. Too little shot wears away the iron tube and cuts but little. It requires some skill in using the right amount of shot. The inventor, L. D.

Connor, of Petoskey, Michigan, claims he can bore large holes this way.

That was one dodge. Another one that I saw there was what is called stock ramming. Some of you may be familiar with that. I was not. There was a timber crib, filled with earth, forming a dam between the present canal and the new lock pit. This leaked, so they drove an iron tube down into it, through which they forced clay to the bottom of the dam, to fill up any openings there. The principle of the hydraulic press is used; it is extremely powerful. Easy enough to burst that coffer dam, although it is 25 or 30 feet thick. In this particular dam, the depth of the filling was about 20 feet, but I have a note here saying this process burst a coffer dam, or forced the whole depth of the filling upwards, when the depth was 100 feet.

They drive down a 3 or 4-inch pipe to the required depth. They drop this pipe full of cylinders of clay, then force the clay out at the bottom of the tube with an iron rod, and a pile driver hammer. The tube is filled and emptied in each spot until enough clay is used. I saw at the Soo where they had spread the wood work to such an extent as to sink the washers in the wale pieces outside of the coffer dam. It puts the material where wanted.

There, they were driving these tubes, and putting down the material every three feet, right across the coffer dam. Then moving to another place, and so on. It stopped the leaks.

Now there is only one other wrinkle connected with that. That is, how they make these clay cylinders, and make them cheaply. They took a common square pointed shovel, doubled it up in a circle, and welded the two corners together, so that a man thrusting it against a bank of clay, would force back on the shovel a cylindrical piece about a foot long. These were put in barrows, wheeled to the place, and dropped into the tube.

There were some other little wrinkles I noticed in connection with that lock that might be of interest, that I can mention more briefly.

The patterns for all the stones were cut out of zinc. It makes a beautiful pattern. The sand for the mortar for that entire

lock is pumped on to the scows and brought to the lock. It comes from the Lake Superior end of the work.

There is one more thing perhaps I will mention in connection with the lock; many of you are familiar with all these things, and some are not. This is a locomotive crane. It lifts 10 tons, reaches 40 feet, and its total weight, with its load, is 50 tons. It costs $4,000.00. One man operates it by five levers. One other man keeps up steam and cares for the two engines, and it works on a track 16 feet guage. This crane hoists, swings, turns and travels, and will do all at once. It will take a stone up, start off down the yard with it, swing about in the right position, and lay it on any pile.

The machinery consisted of two engines, both connected to do other service; also of a hoist, of shafts and gears for locomotion, also of shafts and gears for turning the crane. The gear frame is made of iron or steel beams. It interested me, to see it pick up a great stone as big as this table and walk off with it.

Now this new lock will cost about five millions of dollars. The dock is supposed to be 800 feet long and 100 feet wide when it is done, and even General Poe, who is in charge of all these improvements, seemed very much surprised when I happened to mention in his presence this fact with regard to the size of the lock pit. The pit is now open from end to end, and the masonry was going in last fall. The pit is about five or six hundred feet wide, and between fourteen and fifteen hundred feet long, and I happened to mention that the lock pit would contain a small sized village. The General said, "What's that?" I said, "Yes, sir, a good sized village, a street down through the middle, and good large sized lots and houses on each side." That is for handling the ships at the Soo.

The problem of the lock gates in that lock is one of the most serious that the engineers in this country have ever had to do with. The gate is to be 100 feet in two leaves. You all know how they shut together in the center. General Poe has considered the construction of these gates so important a matter that he has had engravings made of all the drawings, and copies of the plates made, to be deposited in different places, and copies of the drawings made and distributed in

widely separated localities in this country, so that they cannot by any possibility all be destroyed at once and the work have to be done all over.

And I come now to speak of the Hay lake channel, below the locks. Sorry I haven't a map, but this channel through Hay lake will bring the navigation chiefly in American waters, instead of on the boundary line of Canada and the United States. Where it now is, both sides have equal rights, and are disposed to be a little high handed in taking their rights, as near as I can discover.

This new channel will shorten the distance between the Soo and Port Detour eleven miles. They are making a twenty foot channel—through the rock they are cutting it twenty-one. The cost of the rock excavation, including blasting, etc., by dynamite, and depositing the rock in a dyke, for the purpose of marking the channel as if it were a canal, is $1.20 per cubic yard. The rock that does not have to be blasted is 57 cents per yard, and I wish to say for the credit of the profession, that this work is being done considerably below the estimates, and the price is running below the estimates more and more as it continues. They expected the work to cost three million dollars, and the expectation now is that it will cost less than two. In fact, less than one and three-quarters is the estimate I have heard. The earth is being moved at about 14 cents per cubic yard, out of that channel; in one case, 13 cents. That will be near enough for you to form an estimate.

The channel is to be 1,300 feet wide on the bottom. That will give vessels room to pass. They have found it very desirable to manufacture the dynamite on the job. The first reason was that the percentage of nitro glycerine in the dynamite did not run even, and they couldn't depend on it, and the next difficulty was the transportation. High rates were charged. So they manufacture their own dynamite and make their own cartridges. It is the usual thing, let me say to those who are not familiar with such matters, for the drill scow, which may be represented by the table, to drill a row of holes along the front side of it, and as soon as drilled, there are 10 pounds of dynamite put into each hole and exploded right beneath one, within 20 feet. All you need to do is to raise yourself on

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your toes and you will escape all harm. The rocks will be shattered below, and be picked up by the dredge. I should like to talk to you about the machinery, but I shall not do it. Visit the works and you will find it of the deepest interest. This drill scow is one of the most perfect pieces of machinery of the kind.

In case any break occurs in any scow or tug boat, it is simply towed up to the machine shop (which is afloat) and fixed. If that isn't convenient, the machine shop is towed over to where the damage is done. This gives us an idea of the magnitude of the work. These men, three, four, five, perhaps, carrying on these stupendous works, costing about $7,000,000, are doing it as a matter of course, and yet there isn't one of us, nor the whole of us put together, that is able to form the slightest conception of what $1,000,000 is.

MR. APPLETON: I do think that now you are about it, and so ably describing those operations, you might elaborate a little more on the drill scow and on the dredges. You have spoken already of some parts of it; each of those drill scows are mechanical work shops, and I think you ought to say a little more, now that you are doing it so ably.

PROF. DAVIS: If it is the desire, gentlemen, I can describe the drill scow. The beauty of it is the economy and the simplicity of it. At the side of the scow is a vertical frame. There are horizontal tracks along the outside of that frame, to which are fastened the trucks, as you may call them, which carry the drills so they can be moved along lengthwise of the scow. These drills are three in number and can all be operated at once. The drills and their shanks of course are of sufficient length to drill the holes down to 21 feet in depth—in fact a little more than that, making the drill shanks over 30 feet in length. There is a blacksmith shop on the scow, capable of keeping drills of such large size in order. On the scow, for the purpose of operating the drills, are large steam engines and boilers for handling different things about the scow, some of which I will mention presently, and for furnishing the steam for operating these rock drills. The scow is anchored at its corners, and is kept in its place and arranged so that the bottom of the channel is completely and systemati-

cally riddled with holes at the corners of five foot squares over all its surface.

I will say a word to the surveying portion of our convention. I like to talk to them. I will tell you how Mr. Ripley finds out, and he would tell you himself if he were not recovering from an attack of pneumonia, I will tell you how he finds out if the channel is the proper depth. He has a float 120 feet in length, with a hole in the middle of it, 100 feet long. Over the hole is a system of windlasses. From these chains are hung connecting to iron bars. By means of instruments, planted on the shore, he will locate that float at any place in the channel that he pleases. First, by means of his tug boat, or any other device, he will move the scow across the channel. The irons being suspended from the chains, sunk to a depth of 21 feet, will sweep the bottom of the channel completely, over 100 feet of its length. There are men standing with their hands on every chain, and the instant the bars touch bottom it is known. The scow is stopped, the sounding rod is set on that spot, the men on shore with instruments take a couple of sights to locate it, and they find that stone if it isn't a couple of inches in size. If any of you gentlemen see any way by which the contractor can escape his duty under these circumstances, Mr. Ripley would be glad to know it.

I was asked to say something about the dredges. I cannot say much to interest you. They put on dredges there that were too powerful at first and had to reduce the power to do the work economically, yet the present dredges astonish most of us. They will cut into solid sandstone rock, tear it to pieces. They bring it up in pieces up to two and three cubic yards. They found that the original dredges of the ordinary dipper pattern were too powerful. They would not work economically. They were not being worked up to their capacity, so the power was reduced somewhat and they are doing the work and making money at the present day, as Mr. Ripley confidently informs me. Where they are drilling their work they receive $1.20 per yard, and where there is no drilling to be done, for 57 cents, and this place where they took out two or three cubic yards is where there is no drilling done.

The dredges are, I think, made in Toledo; simply good,

plain, powerful machines, no nonsense, strict business. There is a great fleet of tug boats, and all that sort of thing. It is seventeen miles to the Soo, and they have their private telegraph wire running down, and everything of that kind in shape, which shows of course the size of the job, and the strength of the men who are dealing with it.

There is one other thing I saw there that some of you may not have seen, and which you have seen accounts of in the papers, probably—what is called the "whale back." The whale back is cutting quite a figure in commerce. It is a very simply constructed plate metal vessel, having very little interior framework. They are simply built for carrying and storage capacity. They are all holds and hatchways, the quarters of the men taking up comparatively little space in the ends. They are built without bulwarks. The sea can wash completely over them. They are vessels of the largest class, as large as can be admitted to the locks at the present day—in depth, not in length. They are 250 feet long, or thereabouts, are made self-propelling and also as tow barges. They can carry freight for $2\frac{6}{10}$ mills per ton per mile. One of them crossed the Atlantic, you know, during the last summer, and I was surprised to be told that it was the first vessel that had crossed the Atlantic without a mast or sail. Possibly that is true. They are a singular looking vessel, but a great commercial success; cheap in the first cost, carrying capacity very great, and the repairs must be slight. Speed is very good, good enough for freight vessels, and they will undoubtedly revolutionize the carrying of bulk freight. It is not expected that they will make any great impression upon carrying package freight, at the present day.

Now that was what I saw when I wasn't fishing.

MR. TODD: I would like to ask if these whale backs are seaworthy?

PROF. DAVIS: I didn't talk with the captains of any of them myself, but I was told by Mr. Ripley, who did, that in one of the worst storms that he experienced, he walked from end to end in slippers, without getting his feet wet. They are long enough to span the space between three waves. That was one of the architectural problems in sea going vessels. If the

vessel is long enough to span the distance between two waves, she may find herself badly strained, but if she can span the space between three waves, she will seldom be very readily misused by the passage of the waves. The shape is such that the waves can have very little hold of her sideways. Starting at the keel, coming out in the ordinary form, then straight up the sides, a short curve to meet deck, which is a flat oval, thus giving the whole cross section nearly the form of a plate girder bridge. Just a small iron tower for the people to live in. It carries from 2,000 to 2,500 tons. The way they build at the present day is governed by the amount of water in the lock. During this summer the water has been very low, and they have only allowed vessels 14¾ feet.

Another thing some of you may know and some not, the passage through those locks is free to all vessels. It belongs to the United States government, and no tolls are charged whatever.

MR. HODGMAN: Speaking to the question as to whether the boats are sea worthy, one of those vessels went across the Atlantic ocean to England, and went around the Horn to Puget sound, and got through all right, except the loss of a rudder plate.

MR. MUMFORD: Around the Horn or through the straits?

MR. HODGMAN: I mean in a general way that she went around the southern continent, but I presume very likely she went through the straits.

MR. MUMFORD: In the connection where Prof. Davis says the length was about 250 feet. A vessel would encounter seas of a much greater length at times. I had an experience myself, right off Cape Horn, in which the captain and I estimated the length of the sea by the length of our vessel, about 156 feet, and we thought the vessel covered one-third of the slant height of one side, which would make 150 feet even.

I was present at a meeting where Captain ———— was present, and he suggested when the argument was made, that the cradle would strain a ship beyond endurance. He had made a test on one of the White Star liners, and found that the straining of that vessel, when she was running before the sea amounted to six inches, with perhaps 300 feet of deck.

PRESIDENT: Oh, yes; more than that perhaps on that sized vessel. Any of you could make the experiment on an ocean steamer, when on board. I think you are right in your statements, but that sized sea is seldom found on the lakes. These vessels are found, I think, very safe lake boats.

I have not attempted to speak of their advantages as ordinary vessels, because I have only wished to draw your attention to what to me is an interesting part of engineering, the naval part, and to suggest to you, something going on within our own borders. Their advantages for bulk freight are in loading and unloading. They are practically open from end to end, when the hatchways are removed. The hatchways are steel or iron plates like the rest of the vessel and secured in place with bolts and packing until they are water tight. The vessel is just as smooth as painted iron. It looks like what its name implies, like a great big whale. They call them pig noses, I believe.

MR. APPLETON: I saw 63 large vessels go through those locks in 24 hours. A person must be there to realize the amount of traffic.

PRESIDENT: I would say in addition to Mr. Appleton's remark, they are not scows, and flat boats, and fishing boats, and tug boats, but the finest class of steel and iron vessels, of the largest size, that money will build. Vessels, the outsides of which are as fine as money will make them, say nothing of the inside.

Well, gentlemen, I must ask your pardon for prolonging these rather desultory remarks so long. I do not wish to interfere with other matters that properly come before the convention.

THE BUILDING STONES OF MICHIGAN.

PROF. W. H. PETTEE.

Some of you may recollect that at a meeting held at Lansing a paper was announced by me on this subject, Building Stones of Michigan. The manuscript I had there was after-

wards printed, giving some little account of the properties of building stones, the things to be looked for and the things to be avoided, and I intimated then that possibly there would be more to be said on that subject at some future meeting. At the time the program for this meeting was made out by the standing committee, it was thought the time had come for me to put on that appendix, whatever value it might have. I want to say, however, that I have no great amount of new information to add to what was said at that time, and have not prepared a written paper. I shall have to rely upon the stenographer for a report of what I say.

The study of the building stones of Michigan, or the study of the properties of the building stones of Michigan, has not been carried on to any great extent, so far as I am aware, by the geological survey, or by any other persons connected with the public works of the State. At the Mining School Mr. Sharpless is engaged at present in the examination of the properties of some of the building stones of the State. I have a letter giving some information of the progress he is making, but not very minute or ready for publication.

During the past year some things have come to light in regard to the opening up of new quarries. Specimens have been sent to Ann Arbor by private parties, but the amount of new development seems to be very small indeed; so, I think, that, if I direct your attention to two or three points connected with what may perhaps be expected here in the State, and what some of the points are that it is desirable for an engineer to look out for, my object will be accomplished.

In the first place, then, we can draw a sharp line of definition between the stones that are found in the Upper Peninsula and those in the lower. There is undoubtedly a large amount of sandstone exposed in good, accessible quarries along the southern shore of Lake Superior. Most of you are familiar with the character of this red sandstone, and know that these quarries (of Lake Superior) have been advertised very largely, and that the stone has been used in the building for the Mining School at Houghton. It is too early to say much about the durability of the stone. I cannot help getting the impression, in looking at it in buildings, however, that the stone is rather porous, and that it will absorb good deal of water.

If a piece of sandstone, when put into water, will take up five or six per cent of its weight by soaking 24 hours, its porosity is about that which you can expect to find in a good durable sandstone. That is accepted as a good limit. I had some specimens brought down from the Upper Peninsula this winter, and they were examined at the laboratory; their absorption ran a little higher, say eight or nine per cent, not enough to reach the danger line, but still a little beyond the line of safety, if we know what that line is. This is not the best of building stone from this point of view, and still not so bad as to be rejected. Looking at the building at Houghton, I could not help feeling that it looks a great deal better now than it will five years from now. I fear that the frost will make its way in and that the sharp corners will be rounded off.

In a report of some analyses of those building stones at Portage lake, I am informed there is a large, an unexpectedly large, amount of feldspar. I do not know whether that will prove to be true or not. Sandstone is made up of grains of quartz sand cemented by some cementing material, and we do not usually find feldspars in these sandstones. Ordinarily the feldspar of the original rock from which the stone is derived has become worn down, carried off in finer form, deposited in clays somewhere else, and we do not often get the feldspar in these sandstones; but Mr. Sharpless writes me that in these sandstones he finds, in all cases, feldspar, and that is an ingredient which might not be regarded as very favorable. It is regarded favorably in stones of a different character, but not sandstone, as it might lead to earlier decay. But whether there is feldspar there or not, I have to say I am in doubt, because within the last week or two specimens of the sandstone have been examined in our laboratory, and we fail to find evidence of the presence of feldspar grains. The chemical analysis shows a great deal of alkali, potash and soda, and these are supposed to indicate the presence of feldspar. Another explanation is that the clay which is present as the cementing material, is of an alkaline character. Some clays do contain quite a little amount of alkali, and it is an open question whether the alkali in the sandstone is due to the presence of feldspar or the presence of an alkaline clay. Questions

of that kind need to be considered with care, and experiments tried, before we can determine positively whether these ingredients are favorable or unfavorable to the durability of these stones. The general impression which I get from such examinations as I have been able to make of the Upper Peninsula sandstones, is that while they are easy to quarry and very pretty, they are quite uneven. Stones from two quarries, looking very much alike, may prove to be very unequal in value. There is no trouble about the strength. The stone is strong enough. There is no danger of crushing, but the trouble, if any, is going to be in lack of durability. Now, if you do not care anything about the looks of the structure, that will not be serious, but for use in cities, or places where architectural effects are to be studied, I am afraid that these stones will wear out a little too rapidly. I do not want to have it go on record that I say that will be the result. It is the impression I get from what study and observation I have been able to make of these stones from the Upper Peninsula.

They seem to be pretty free, however, from anything in the way of sulphur, pretty free from iron pyrites. That is in their favor. Iron pyrites, the common mineral you see so frequently in coal and rocks, yellow, brassy looking cubes, is generally looked upon as one of the most undesirable elements in building stones; and, if that is absent, that is much in their favor. So far as I have been able to ascertain, the presence of iron pyrites is rather rare in Michigan sandstones.

In regard to pyrites and its bad effect upon building stones, I may say here, not specially in connection with the building stones of Michigan, but building stones in general, that we all know iron pyrites has a very bad name; and it deserves it in many cases, but sometimes not. There is iron pyrites and iron pyrites. The chemical combination in iron pyrites is that of iron and sulphur. We know of several different combinations of iron and sulphur, which do not differ much in general appearance. The ordinary observer would call everything of that brassy kind, probably, pyrites, and let it go at that. But when these are studied with more care, using a microscope, we find that there are certain varieties of pyrites that are easily decomposed, very susceptible to the action of water and the

atmosphere. But there are other varieties which are not affected in that way at all. You will see a stone put in a wall of a building, perhaps, looking perfectly free, clean and pure, and in the course of a year or two it will be covered with iron rust, while in another stone containing visible pyrites the crystals will stay as bright as ever.

You may not know why it is, that some iron pyrites decomposes readily and some does not. It has been made a subject of study recently and the result may be stated in this way: There are small differences of specific gravity in these varieties of iron pyrites. They run up to 5 and sometimes a little more, $\frac{1}{10}$ perhaps, and they also occur as low as $4\frac{8}{10}$, or, in some cases, $4\frac{6}{10}$. Now these differences seem to be pretty small, but they are connected with differences of internal structure, and we find that those slight variations in specific gravity point to differences of density in the molecule, differences in compactness of the atoms in the pyrites; and if the specific gravity of your iron pyrites is $4\frac{95}{100}$, you will be pretty sure that the weather will not affect it; but if the specific gravity is $4\frac{9}{10}$ you can be pretty sure that in the course of a few seasons it is going to rust and discolor the rock.

To return to these sandstones of the Upper Peninsula, we have every reason to believe that they will be very valuable for a great many purposes, although I fear they will not be so desirable for work that is to retain architectural beauty for any great length of time. I hope I am mistaken. Some of the members present can, perhaps, give additional information, and may know of buildings that have stood for a good many years and retained their beauty; and certainly no one will be more glad than I, if the impression I have gained is corrected by those better informed. The sandstones in the Upper Peninsula seem to be about the only variety of stone there available for building purposes in general. They are of a high geological age, going back to the paleozoic formations. There are, to be sure, a good many limestones, found at the southeast end of the Upper Peninsula, near Mackinaw. I have not heard of their being used to any great extent. A sample from a quarry in that vicinity was brought to me last year, the owner thinking it might be valuable as a marble. The stone had

taken a pretty good polish, but when looked at carefully and with the microscope, it appeared that the surface was not exactly smooth. It was pock-marked, and showed little indentations about the size of the head of a pin, some larger and some smaller; and, on being broken, the stone revealed the fact that wherever one attempted to get a polished surface, even three or four square inches, three or four little openings would be cut across, which would open channels for the penetration of moisture, and soon cause the polished surface to disappear. It does not seem to be a desirable stone for a marble that is to take a good polish. It would be too coarse grained and have too many openings.

In the Lower Peninsula we meet with a difficulty that we all understand; the country is covered very largely with gravel, and we have to go down from 50 to 200 feet before we get a good rock.

I have not gathered any special information that is new in regard to the few quarries that are opened in the southern peninsula. You know of them, some at Grindstone City, at Ionia, and several others, but I have no additional information in regard to them beyond what was included in my paper three or four years ago. The geological age of the rocks in the Lower Peninsula is, generally speaking, more recent than that of those in the Upper Peninsula, though still paleozoic.

I see no reason why we should not find good building rock in the limestones, though we do not get good granite rock. There is a good supply of granitic and crystalline rocks in the Upper Peninsula, but I do not think a quarry has been opened that would supply a rock to compete with the granitic rocks of the East, and Appalachian region.

Now, Mr. President, in this way as you see, without manuscript and quite off-hand, I have presented a few points I thought might be of interest, and with this I will call the paper closed for the present, subject to such discussion, to criticism, and retraction as the case requires.

PRESIDENT: I am sure we are all glad to hear from Prof. Pettee on this subject, and in this practical kind of a way, and I think many of the members, though whether they are here or not I am unable to say, will be able to add something to

what he has already given us with regard to their experience with these different stones from different localities.

I would like to ask if it is possible to tell from the surface exposures of the Lake Superior sandstones anything about how they will act. There are great cliffs exposed in different localities. Also, I would say on the general subject, the use of building materials, in which stone forms a large part, that the climate of Michigan is so extremely trying on the exterior of all buildings, that I think materials for any permanent buildings should be selected with the greatest care and in the light of all the information that can be obtained from experience, or which can be got from anywhere.

PROF. PETTEE: In regard to that matter of natural exposure. I do not think you can tell very well from the outcrops of the exposed cliffs around the shores of Lake Superior as to how the stone will work when put in a building. One reason is that the conditions are very different. The conditions to which the rock is exposed, are far different in the quarry than when in the building.

It is pretty generally believed, and recommended in our books of reference, that the best thing an inquirer can do is to go and see where the rock has been exposed, and if it has stood exposure there pretty well, it can be believed it will stand exposure in the building. The principal criticism against that belief is that when you come to put the stone in the wall of a building, exposed to the atmosphere of a city, it will very likely deteriorate much more rapidly than it would in its native fields, and instances are given, and might be referred to by the works at hand here, where rocks from a given quarry that have been used in public buildings in a country community, have stood for centuries apparently without injury, while rocks from the same quarry, taken into the cities, have crumbled away and become disintegrated within a comparatively short time. The atmosphere of our cities contains a rather large amount of sulphuric acid and other gases, which seem to have an injurious effect on the stones exposed to view. That is a subject in regard to which I am unable to give you any quantitative statements at the present moment, but there is no doubt about the fact.

In answer to your question, Mr. President, I would advise you not to depend with much certainty on the character of the exposed cliffs. It is not a safe guide. It gives you some information, but nothing you can tie to.

MR. SKEELS: I would say for the information of some of our friends that the Michigan Trust Company have used that Portage stone for two stories of their building, and it can be seen by going on the ground.

MR. AMES: The Hermitage on the corner of Canal and Bridge streets is trimmed with the red sandstone, Lake Superior stone, and the Michigan Trust Company building is the one mentioned last evening, one block from here.

PRESIDENT: Mr. Forster, who is not present, is more familiar, perhaps, than the rest of us with the localities mentioned; he could tell us something of the history of these things if he were here. Sorry he is not.

PROF. PETTEE: If I might be allowed to add just one word, this subject of the importance of building stones in Michigan is one which I understand the geological survey is beginning to take up and study with a little more care than has been done heretofore. With reference to that matter of feldspar, Mr. Sharpless wrote me that in all of his reading and research he had never found any reference to it whatever, and he is preparing a monograph on the subject of the strength and chemical composition, and physical properties of such stones as are used for building purposes around the peninsula. I am looking forward to his report with considerable interest.

The secretary calls attention to the fact that I omitted all reference to a kind of building stone that personally I am quite familiar with, the hard-heads and boulders that the southern peninsula is full of. The stone was brought down from the Upper Peninsula in the glacial period and distributed around here. I had in mind, however, the stones that are quarried. Down in our neighborhood, Ann Arbor, the farmers have cleaned the fields pretty free of these hard-heads, but it makes very excellent building stone. It is not a building stone that will become an article of export.

MR. HODGMAN: They have in our section a very important use as foundations for buildings. They are used almost

exclusively for that purpose. Every building has them for a foundation wall. I have noticed in some cases whole buildings built of them, and it seemed to me that they were about as ornamental a stone as we had. The professor says they were brought down from the Upper Peninsula. The question is, if they were brought down from there, are there not some left there in places—the original quarries from which the glaciers took them.

PROF. PETTEE: The professor of architecture at the Columbia College School of Mines, was particularly struck with the beauty of the Ann Arbor buildings made from these hard-heads, or boulders, several fraternity houses and churches, and he wanted to know where in the world we got that stone that gave such a beautiful purple tint. I told him we had collected it from all parts of the northern peninsula, and the ice had brought it down. No two blocks of stone in these buildings are exactly the same. The boulders are found on the ground in masses as large as a horse can draw, and when they are broken open each one is different. I do not think that any one kind would be so desirable. It is the mixture that makes the beauty. If we went up to the quarries in the Upper Peninsula we should have to do a good deal of traveling, but when we have them brought down by natural forces the expense of transportation is reduced to nothing.

MR. HODGMAN: Where I reside, we have had difficulty in getting rid of them in some places.

MR. SKEELS: I would like to ask the professor if he knows anything of the stone they are quarrying at Holland. There is a great deal being used here for foundations. It is soft when quarried, and gets harder as it is exposed to the air, and makes a very nice looking foundation.

PROF. PETTEE: I have never seen that stone at all.

MR. SKEELS: And while up I would say that one of our enterprising citizens, or two of them, the Fox brothers, have built a house, corner of Cherry and College avenue, of these hard-head blocks. It is a very splendid structure. As the professor says, there are no two of them that look alike.

PRESIDENT DAVIS: While we are speaking about the field stone, I would like to ask Prof. Pettee if I am right in suppos-

ing that the field-stone of eastern Massachusetts, whose exterior appearance resembles our field stone somewhat, cannot be worked at all as we work our field stone, with hammers and fire, I am under that impression.

PROF. PETTEE: I do not know any reason why they should not. I was born in eastern Massachusetts; my father had a farm there, a few miles out from Boston. I was the youngest son. The work was all done before I was born, but, as he was troubled with a large number of field-stone boulders, he built with them what was known throughout the neighborhood as "the stone barn," 100x40, and he used many large stones in the foundation, which was about eight feet thick. That is a standing example of field-stone in a building in the neighborhood of Boston.

PRESIDENT DAVIS: What I refer to is the flat surface. We take our 30-pound hammers for pounding, and sometimes we use fire to get a crack started. My father, who has had plenty of experience, when I told him of the manner in which we worked our field stones in this country, laughed at the idea that anything of the kind could be done with Massachusetts field stone.

PROF. PETTEE: I know we used to blast them, in Massachusetts. Those of my friends who have visited me at Ann Arbor have expressed considerable surprise at our method of treating these stones.

PRESIDENT DAVIS: I was questioning whether my father's limited experience, was really a representative fact or not, that the eastern stone could not be worked as we work our Michigan field stone. I thought there was a suggestion in it for us.

PROF. GREENE: Michigan stones are granite I believe. I know when I was in Maine they would break them up with a hammer.

HYDROGRAPHIC SURVEYING.

JOHN HARRIS FORSTER.

Surveying on land is, of course, a familiar operation to most of you. All are not as familiar with hydrography.

The surveys of sea coasts, of the great lakes and rivers of this continent, have been conducted by the government, thereby debarring private enterprise and affording no opportunity for practice to the majority of civil engineers and surveyors. The writer having had some experience in this work, has been encouraged by your worthy secretary to submit some practical points for your consideration. He will not undertake to unfold the whole scheme of hydrographic surveying so ably carried out in the survey of the northwestern lakes, for instance, by the government of the United States through its war department. In brief, he will attempt only a few disjointed sketches, hoping thereby to give you, who may be interested in the subject, some idea of the work.

The survey of the northern lakes was not limited to mere off-shore soundings, but embraced shore-line surveys and topography, and a limited reconnaissance of the interior; also, deep-sea soundings, primary and main triangulation, reaching across rivers, bays, and the wide lake itself. All rivers of commercial importance, present or future, emptying into the lakes, were accurately surveyed as far up from their mouth as the case required. Especial attention was given to the mouths of rivers where sand bars and clay banks occur, choking the free outflow of the stream. The soundings at such points were minute and comprehensive, covering the whole delta. The finished chart would show a complete picture of the bottom, with its shoals, bars and tortuous natural channels. The material composing the bottom, ascertained by the lead or by borings, whether of sand, clay, gravel, boulders, hard pan or solid rock, was carefully noted. A plan was thus given which would be of great service to those who should follow in the work of river and harbor improvements.

The survey of the great lakes extended through many years, four or five decades, and was completed only a few years ago. It had for its superintendents, from time to time, army engineers who, later on, became distinguished generals in the war on the union. Captain Meade was one of the most brilliant and accomplished of these superintendents. Serving under him were many civil engineers. He called them his "boys." The "boys" loved and respected their commandant. Returning from the victorious field of Gettysburg, after receiving an ovation in Detroit, he sought out his "boys" and spent a delightful evening with them, recounting not the deeds of ensanguined Gettysburg, but the old camp stories of the lake survey.

The survey was well organized and well equipped. It consisted of several shore parties or camps. An iron steamer was attached. Its duty was to place the shore parties in the field in the spring, visit them once a month with the mails and provisions, and for inspection. The steamer also made the deep-sea soundings, and conveyed the officers conducting the main triangulations to their several stations, miles apart.

Belonging to the survey were several independent field parties. They were widely posted along the chain of lakes.

There were about twenty-five men in each party; four officers, one foreman, one cook; the rest were boatmen, chainmen and axmen. They lived in tents. There were usually two or three cutter-built, six-oared boats and one bateau, which last was used in transporting provisions and camp equipage belonging to the party. In camping the places preferably chosen were sheltered bays or mouths of streams, but sometimes the open roadstead had to suffice for the anchored boats. During heavy storms, in such case, the flotilla was hauled out on the beach. The tents were usually pitched on high, dry land, under the pine trees, near the shore, with a water view and a broad sand beach for a promenade. Thus situated, the camp, with its white tents placed in order, with underbrush cleared off, presented to the view a cozy hamlet in the wilderness. For many years the camps were isolated. There were no settlements, no human habitations, except the Indian wigwam, to be seen. During the entire season, it may be, the party saw no

one in civilized garb, except the men on the survey steamer. Long stretches of the lake country was an unbroken wilderness. Dropped some still afternoon by the steamer on a wild, untracked shore, the surveying party was left to its own resources. Before the retiring steamer was out of sight the camp was pitched, the stars and stripes flung to the breeze, the cook busy over his stove and the camp fires blazed cheerily. Our surveyors were "at home" to all callers, including the impudent mosquitoes.

Camp comfortably established, on the morrow at 5 a. m., real work began. The men were classified and assigned to the command of the several officers. Thus there were two or three sub-parties in camp. The senior officer commanded the whole. Surveying instruments were brought out and adjusted, and sounding lines compared. One gang of men was set to work making buoys, another was sent to clear out lines along shore, erect sounding stations, instrument stations, as well as secondary triangulation stations. All were busy as bees. On the first clear night an observation was taken to determine the true meridian and variation of the magnetic needle. Every ten miles, as the work progressed, new observations were made for the same purpose. The shore line was run with a theodolite. The start at the initial point was from the established meridian. The needle was never used, except to get the variation.

HOW TO MAKE BUOYS.

The buoy is an important factor in hydrography. On the survey a good practical buoy was gradually evolved. Dry cedar trees were procured from the swamps. This wood is light, buoyant and not easily water-soaked. A tree about one foot in diameter was best. It was cut into pieces, two and one-half to three feet long. One end was shaved off like a truncated cone and a two-inch auger hole bored into it. Into this hole a spruce pole about two feet long, two inches thick, with a wedged end, was driven firmly. A hole was bored through the lower end of this stick large enough to let the anchor rope pass through and tie. The top of the buoy, sawed off square, was also bored and a light spruce staff, five or six

feet long, inserted and securely fastened. On this staff a small flag, one foot square, was tacked.

A large number of buoys and flags were required. The flags were made of cotton; white, red and black were the colors preferred. Practice determined that these colors were best for use, under all circumstances. This was important; it is often difficult and perplexing to make out a buoy on the water.

These primary colors, so to speak, admitted of many combinations. For example: No. 1 might be solid white; No. 2, red; No. 3, black; No. 4, white and black (horizontal bars); No. 5, red and white; No. 6, red and black, and so on. When these combinations were exhausted the colors were placed vertically, with the same number of variations as before. If more flags were required, diagonal bands were used. These flags were all made in camp, from bolts of cotton cloth.

Each book of soundings and each book of shore-line work, had these buoy flags recorded and painted in them and duly numbered, in order that the observer, on land or water, might have a ready reference. With naked eye, or telescope, the observer could pick up one of the many fluttering flags in the offing, when, by referring to his book, he would find its name. In sounding, before the boat leaves the shore, the officer in charge must ascertain definitely which flag or buoy he is to steer for. There must be no doubt about the buoy; any confusion of flags would cause a loss of a line and a breaking up of the plan for the day.

The buoy ropes used were of manilla, one inch in diameter. The anchors, carefully selected stones found on the beaches and weighing from 10 to 50 pounds. A coil of rope was carried in the boat.

In placing the buoys we ran out from the shore, sounding the while, until we found one fathom of water. Upon the six-foot curve, technically so-called, the first buoy was dropped. The line was extended up and down the coast several miles, but within a convenient row to camp. These buoys in line were several minutes apart or from 500 to 1,000 feet, according to circumstances. The character of the bottom determined how near or far apart buoys should be placed. The engineer was called upon to exercise his best judgment in the matter.

With a smooth, even, gradually descending bottom, the buoys could be placed systematically; but with a bottom irregular, with abrupt depths and shoals and twistings, no fixed plan could be followed. The first line of buoys dropped, the boat's prow was turned seaward and proceeded until the two-fathom curve was found. Then another line of buoys was strung out. In the same manner the three-fathom curve was found and marked with buoys. Care was taken all the while to place the buoys at equal distances apart on all the curves, or lines, so that, when the work was done, the field in view was covered with many bright, fluttering flags, which marked a number of squares on the water. The shore parties were required to sound out only to the three-fathom or eighteen-foot curve, with small boats. The steamer engaged in deep sea soundings ran in to the three-fathom curve and thus connected the whole work.

This was the devised plan when all was plain sailing—when the coast was regular and the bottom descended gradually from the shore, shelving into deep water.

At times the conditions were altered. A submerged or submarine point would be encountered. One six-foot curve, usually a few hundred feet from shore, would take a turn suddenly out into the lake and we would have to row a mile to find six feet one inch. The twelve-foot curve would be equally preposterous, while the eighteen-foot curve would be three or four miles from land. This irregularity was followed out until, from some extreme point marked by a buoy, the curves farther on began to retreat toward the shore and resume their normal place. The sounding had developed merely an unexpected shoal point, putting far out into the lake. Of course the buoys on this point did not stand in the regular order before deliniated. Their location was more perplexing, from boat or from shore.

The first section or division of buoys being placed, the work of sounding began. A six-oared boat was used. The leadsman stood on a platform in the bow. The coxswain and an officer sat in the stern. A lead line was used. The coxswain's duty was to keep the boat in a straight line for either buoy or shore station. The officer, with watch, pencil and

note book in hand, gave the order to "heave." The boat was rowed at about four miles the hour, but winds, waves and currents were likely to vary the even motion. In shallow water the lead was cast every quarter minute; in deeper, every half minute; in deeper still, every minute. The officer must be argus-eyed, quick and nimble. He marks time, gives the order to "heave" the lead, notes in his book the sounding called off by the leadsman, sees that the men are pulling steadily, and that the coxswain is not napping or zigzagging, or that the wind or currents are not driving the boat off a true line. The leadsman must be quick to cast his lead and call off, giving the depth of water to an inch, character of bottom, whether of sand, gravel, clay, boulders or hard pan. All these things must be quickly noted by the engineer, and while the line is being run there is no pause or cessation of close work and attention.

In sounding from shore stations to buoys, from buoy to buoy, the whole surface, nearly, is gone over. The squares are sounded, while diagonal and double diagonal lines cross the squares. Thus the bottom of the lake is pretty thoroughly explored. No considerable shoal or even boulder escapes the searching lead. .On a hot summer's day sounding in a small boat is rather monotonous. The direct and reflected rays of the sun are scorching; foggy or windy weather is perplexing, but a calm day, when the signal flags hang limp to the mast, why, you simply have to row to the shore and take a siesta under the greenwood trees.

The water survey is connected with the shore line by means of the sounding stations. At a distance to correspond with the distance between the buoys in front, these sounding stations are erected. Theoretically this is correct, but a crooked shore sometimes prevents exact practice. A sounding station is one of the shore line points. It is marked by a stake and by a tall pole bearing Roman numerals. Barrel staves, whitewashed, were found to be excellent materials out of which to form the numerals. The numbers could be seen with the naked eye a long way from shore. The whitewashed figures, on a background of fir trees, were conspicuous objects.

LOCATION OF BUOYS.

These buoys are instrumentally located by the engineer running the shore line. This engineer usually had his hands full. At every station at which his instrument was set, he was obliged to sight at, or take a shot at, every buoy in sight. Twenty or fifty buoys could be seen and their position, by angles, be noted in his field book. Thus, by repeated observations, from different stations on shore, he was able to make many intersections, and these intersections, when he came to plat his work, defined the position of each buoy. Buoys if let alone would stand a whole season; but when a particular section on the water was completed, the buoys were taken up, carried forward down the coast, and placed out again. If for any reason a buoy could not be located from the shore a sextant observation at the buoy settled it.

In deep-sea soundings the lead was cast once in five minutes. Where the line was cut off by approach to the shore, in three-fathoms water, a sextant observation fixed the point. These lines were carried across all deep bays and across the lake itself.

PLOTTING SOUNDINGS.

In plotting soundings it is found that vastly more figures are taken than a sheet of paper will hold. Therefore characteristic soundings are chosen, care being taken to select always those figures indicating the shoalest water. There is no danger in deep water; shoals are what navigators fear. In deep sea sounding the steamer often runs against a snag, so to speak. The leadsman monotonously sings out "ten fathoms," and again, after the lapse of five minutes, "ten fathoms," then five minutes later, with a quick, sharp cry, "two fathoms!" Then all is commotion. The drowsy officers are instantly on their feet and the bell "stop her" is rung. The anchor is dropped and the boats lowered. A rocky shoal is discovered in the midst of the waters. A survey of the shoal is made; it is found to be several acres in extent; at one point there is scarce ten feet of water. A water station is erected on the shoal as a warning to mariners. This station is connected by main triangulation

with the main land, and its geographical position fixed. Subsequently a lighthouse is built on this isolated, submerged island.

WATER STATIONS

are large or small in accordance with the depth of water in which they are to be placed. The station is in form a tripod. Sticks of cedar or spruce, from fifteen to thirty feet in length, eighteen inches diameter at base, tapering to the top are best. The three sticks are bolted together flexibly at top. They are spread so as to make a firm base. They have to resist the action of the wind and waves. Eight or ten feet from the top, strong cross-pieces are spiked on, as spreaders. The lower ends of the sticks of the tripod are sharpened, sometimes shod, with iron, in order that they may sink into and find a firm footing on the shoal. The station is built on shore and towed out to the shoal, loaded on a bateau or raft of boats. Then it is dumped overboard on its feet. A platform is built on the girders aforementioned, and loaded with stone to hold the station in place. A tall flag pole with a flag surmounts the structure. Plenty of whitewash is applied. The station thus becomes a cheap and conspicuous day beacon, and will stand until the ice carries it off the succeeding winter.

SHORE LINE SURVEYING.

Starting at the initial point on the determined meridian, the surveyor begins work. His skilled foreman has already cut out his lines and selected his points of observation. To do this requires good judgment on the part of the foreman. On a winding, wooded shore his aim is to get the longest lines practicable, without running into the water on the one hand and into the bush on the other. After the surveyor has made his instrumental observation, always reading both verniers and recording the degrees, minutes and seconds, one of his trustiest men takes his theodolite, carries it forward to the next station, sets it over the stake and levels it. Meantime, our surveyor starts his chainmen, following and watching them closely and, at the same time, sketching in the topography minutely. He

is kept very busy. Arrived at the second station, he takes his shore line instrumental notes; then he sights at all buoys in range, at every secondary and primary station to be seen, backward or forward or across the bay. Thus he multiplies checks upon his work. It is hard, laborious, absorbing work. Accuracy is indispensable. From five o'clock in the morning until sundown there is no let up, except for a hasty luncheon at noon. The dinner pail always accompanies the party. At the end of a hard day's work the party is often five miles from camp. A rapid walk thither finishes the day—and the engineer also. A frugal supper of tea, hardtack and pork awaits him, and he is invited to sleep on a downy couch of cedar boughs, covered with a buffalo robe and blankets.

There is an astronomer and computer attached to these surveys who have well known special duties to perform.

Base lines are measured by the same men who do the general surveying.

I have now given you a hasty and very imperfect sketch of hydrographic work on the lake survey.

Detroit city was for many years the headquarters of the survey. Late in the fall all camps were broken up and the parties returned joyfully to the city. The men were discharged, while the officers settled down to office work. Computations and plotting the survey on a large scale was the work of winter. This was done by the men from the field. Office draughtsmen took these large charts, reduced them and prepared a combined general chart for the use of navigators, after publication.

The writer will now give some examples in hydrography not recorded in the annals of the famous lake survey.

Having been transferred to the river and harbor improvement department, he was ordered to proceed to Lake George, St. Mary's river, Michigan, to lay out the work for the proposed dredging therein, and in Neebish rapids.

His commanding officer, an accomplished engineer, afterward a general of division in the union army, and who was shot to death at Chancellorsville, had just returned from the western deserts where trees and water were particularly scarce. He took upon himself the task of providing, while in Detroit, buoy anchors and staffs, to be transported by steamer several

hundred miles to Lake George. He had a lot of cast-iron mushroom anchors, weighing about seventy-five pounds, made. He sent up to the hickory forests of St. Clair river for green poles, twenty feet long and four inches in diameter at large end. These were the materials for his buoys. The idea was brilliant. The writer quietly asked: "What shall we do if we find more than twenty feet of water, or very shallow water? These poles are not flexible; they will not stand up if the wind blows and waves roll." No answer was vouchsafed. Military discipline must be maintained. At length we reached Lake George and pitched camp on a small island. We had to clear away the timber. The shores of Lake George were clothed with a dense growth of cedar and maple trees. The first observation made by our gallant commander was: "Why, there seems to be nothing but woods in this country; we need not have brought those poles all the way from Detroit." There was a superfluity of boulders on our island, just right for buoy anchors.

We began without unnecessary delay to lay out the channel to be dredged. We used the mushroom anchor buoys. We set them with care, and the double line of hickory poles standing proudly above the waters was really like business.

There was a little puff of wind that night and some sea on. When we resumed work next morning we rowed out to the channel, but not a flag pole was to be seen. It was suggested that the Indians had stolen the buoys for the sake of the iron mushrooms. But we cautiously pulled over the ground and, as the water was very clear, we could see the bottom plainly, and our lost buoys lying there prone on the ripple-marked sand! They were suffered to remain there.

The writer was then ordered to make some buoys to suit himself. With plenty of the best material at hand the men soon produced an ample supply, a la lake survey.

In reconnoissances of narrow and crooked channels the writer found that the ordinary cedar buoy, as described, was too cumbrous for rapid work. So he invented what he named a duck buoy. This was simply a piece of dry cedar, one foot long and three inches thick, with an auger hole in the middle. A piece of marline was tied in this hole with a light stone

anchor at the opposite end. A pile of these buoys were placed at his feet in the boat. As the boat proceeded and the depth of water called off, at a certain depth, say seven feet, he would immediately throw a buoy overboard, which floated like a duck. The next sounding would perhaps be twelve or fourteen feet, showing we were in the channel, and the next heave would be in seven feet, or on the channel bank, and then over would go another duck. Thus a line several thousand feet in length would be marked out on the left bank. Returning by the right bank a parallel line would be formed, thus showing roughly the course and width of the hidden channel. Those ducks were admirable guides; by them we could deliberately set out the permanent buoys and make exact soundings.

Lake George, a widening of St. Mary's river, is in shape much like an egg, about twelve miles long and four miles wide in the widest part.

The earlier fur-trading vessels and all commercial vessels of necessarily light draft, down to 1858, followed the natural channel, which swept around near the east, or Canadian shore, in British waters.

The lake survey early in the fifties made a minute survey and chart of Lake George. The chart, in addition to the old British channel, showed a winding, partial channel, close to the west, or American shore. By much dredging this channel could be rendered navigable. From patriotic notions, doubtless, this inferior channel was recommended by the engineers as best for improvement, being entirely in American waters. Accordingly this channel was staked out by the writer and the dredges set to work. They excavated from the first 2,000 cubic yards per day, in the soft clay.

Occupying the middle of Lake George there was an immense plat of refractory red clay. It was this dam, so to speak, that crowded the waters into the deeper troughs which wound around near the main land.

The water was beautifully clear, the overflow of that great natural spring, Lake Superior. One day the writer climbed an old triangulation station, left by lake survey parties, for observation. The whole beautiful lake lay under his feet. To his surprise he saw, extending half way up into the clay flats,

from the lower end, a narrow, deep blue streak of water, like a finger. Surely, he said, there must be deep water there. He hurried down, rowed to camp and examined a chart of the lake. The chart indeed showed at the point under examination numerous soundings of twenty-five to thirty feet, apparently in line, running in a northerly direction, but the proper distinguishing curves had not been drawn. Perhaps the men were careless in sounding and, if the sudden jump from seven feet, the depth of water on the clay flats, to thirty feet, aroused their attention, they probably concluded that the thirty-foot soundings indicated nothing more than pot holes. Yet, the channel was as distinct as anything could be. The writer, in his small boat, found it so as he rowed from one end to another.

This important discovery was reported to the war department. A commission of engineers was sent from Washington to examine and report on it. They came, saw the channel as defined by numerous gay flag buoys, stayed one hour and returned whence they came. The position and importance of this new channel was apparent at a glance. Its adoption for improvement, instead of the west channel where the dredges were at work, was unanimously favored, because it was more direct, was in American waters, and would cost many thousand dollars less.

Two weeks later, orders came to move the dredges over to the new ground. Anticipating the final adoption of this line, the writer had buoyed it out, so that within one hour after he received his orders to make the change, the dredges were swinging their cranes in the new channel line. It was at midnight when this was effected. Several thousand dollars were thrown away by dredging in the wrong place. The completed channel is the one now used by the vast commercial fleets that visit Lake Superior.

At the Neebish rapids, below Lake George, the writer had a conundrum to solve.

At the Neebish, the mighty river St. Mary is crowded into a narrow bed with high ridges of quartzite rock on the east side.

Right in the middle of this narrow passage, in some past geological age, there was dropped an immense mass of boulders

which now form a dangerous shoal reaching almost up to the surface of the water. On either side is a narrow channel eighty feet wide and from fourteen to twenty feet deep. The navigation is exceedingly dangerous. The common, most used channel, is the one on the Canada side. The lake survey party found the west, or American channel, and pronounced it preferable to the one on the east side, being straighter and shorter, and carrying at least fourteen feet of water all the way through. The course through it was marked by the engineers by forward and back sights. On this course lanes fifty feet wide were cut back into the woods, cleared of all timber. High, whitewashed stations were set up in these lanes, forming conspicuous guides. As the vessel approached the rapids, these stations were brought in range and, on that range, the vessel was assured of sufficient water to carry her through safely. Large steamers were confidently invited to try the new channel. One, the Planet, accepted the invitation and, keeping close on the ranges, managed to stave a hole in her bottom the first time trying. Of course, navigators condemned the new passage vigorously. It was asserted "that them lake survey chaps were humbugs." That was the opinion of old salts. The surveying steamer, with chief of survey, immediately visited the spot and spent two days in sounding and sweeping the bottom with drag ropes, all in vain. No rock or obstruction could be found. Consequently there was a counter blast on the part of the survey, and the captain of the injured vessel was accused of running out of his course. Nevertheless, the new channel was tabooed by navigators, one and all. Desuetude was the fate of that modern discovery, the new channel. The logic of fate was against it.

The officer in command of the harbor and river improvements believed in that rock and was determined to find it. Many plans were made on paper, some quite expensive, to achieve that object. But, planning in the city of Detroit was not effective. The writer was finally ordered to find that rock somehow. The ways and means were left to his own invention when he should arrive on the Neebish. In due time, the writer, in command of a Mackinaw boat, rowed by four half breeds, whose dialect was a compound of Chippewa and French,

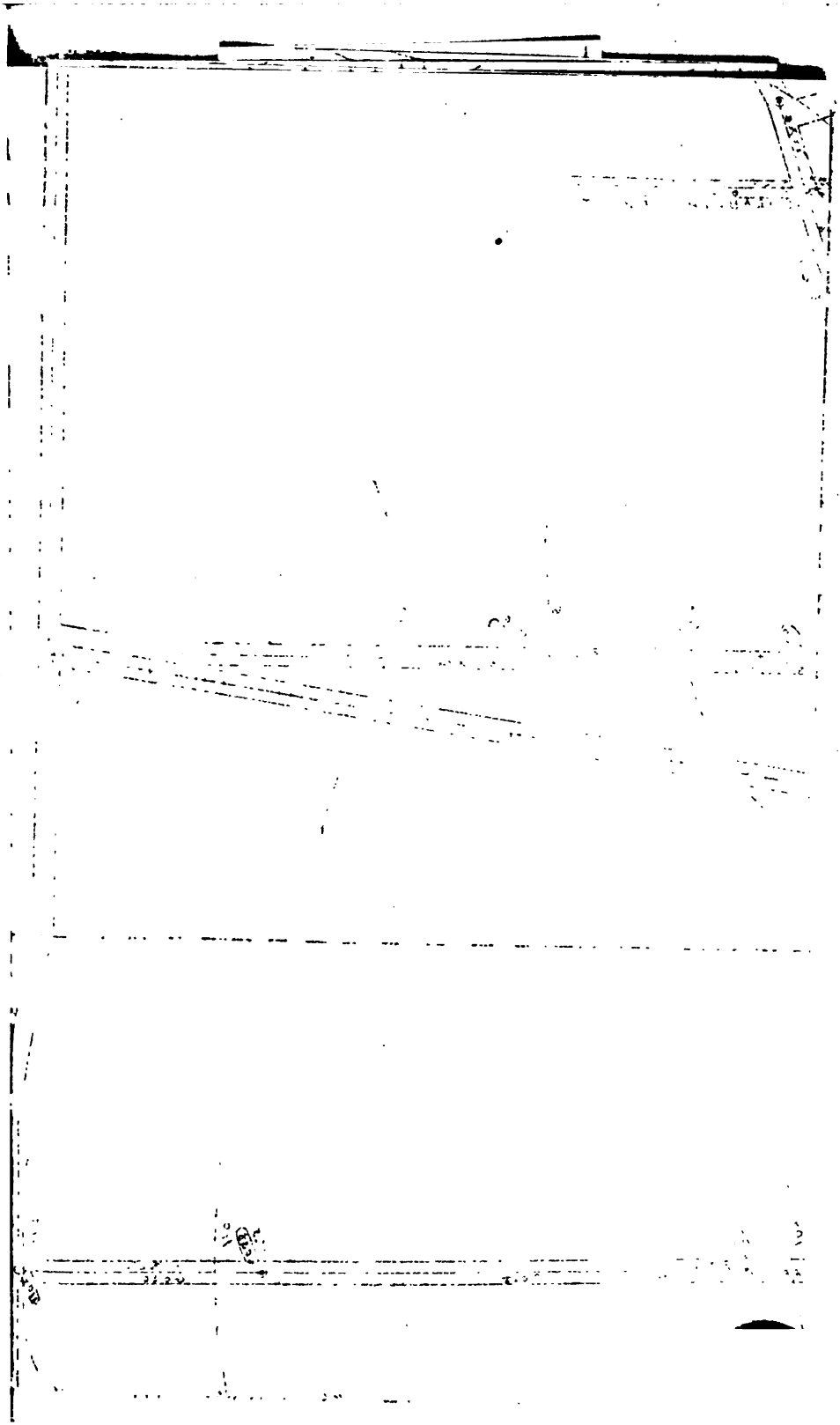
with ropes, buoys, sounding lines and provisions in abundance, pitched two tents on the American side of the rapids. He then sat him down on a boulder to study the conundrum. The difficulties of the situation were apparent. The chief one was the current; it swirled past at the rate of six miles per hour. It was impossible to row the boat against the stream; impossible to row straight across. How then should the sounding be done? As night closed down upon the dark, rushing river, no answer came. The writer, with no appetite for supper, brooded over the camp fire for a while, listening to the gutteral converse of his men, who could give him no advice, at length sought his tent. Lying on the ground, in the stillness of this solitude, only the murmuring of the rapids could be heard, but with awful distinctness. No sleep visited his eyes, but far on in the night a plan of procedure developed itself in his weary brain. At daylight the camp was awake and alert. A cup of coffee and piece of hard bread sufficed for breakfast. Then we prepared to execute our plan. We had a long coil of buoy rope, 800 feet in length. This we proceeded to measure and mark off every ten feet with strips of red flagging. We cut a light spruce sapling, twenty feet long, peeled it, and marked it off in feet and tenths, thus making a sounding pole. We loaded the Mackinaw with these, some large buoys and a small anchor. We towed the boat up the rapids into still water, and embarked. Rowing some little distance up stream, we threw over two buoys, in range with the range stations on shore. We dropped anchor at the lower buoy with our long rope fastened to the anchor. The men were directed to drop down stream backward, keeping the boat exactly on the range buoys and paying out the rope slowly. The writer, amidships, used the sounding pole, sounding at every tag of ten feet. Indeed, he kept the pole on the bottom as near as he could all the time. Slowly we dropped down. The pole measured fourteen feet depth, again fourteen feet—fourteen feet—fourteen feet—seven feet—hold on to her! Overboard went a duck buoy. Then we felt around for the rock. There it was, sure enough! We threw over a large buoy with a heavy anchor, to mark the rock permanently. Singular enough, the rock was found to be exactly on the range line. The closer a vessel clung to the range, the

more certain she was to hit the rock. There was plenty of water on either side of the rock. The writer, within a day or two after finding the rock, piloted two vessels laden with iron ore through the channel, keeping just west of the buoy.

Within one hour after work began, that diabolical rock was spotted. We returned to camp joyfully and spent the rest of the day fishing. Splendid, gamy bass in those rapids!

Late in the summer we dredged that rock up. It took all day to do it. From its peculiar shape it eluded the dipper. At length the dipper seized it. The weight made the chains snap, the crane creak and groan, bringing the bow of the dredge under water. At last it was swung onto the dump scow. It was a huge sandstone boulder, weighing several tons. It was badly marred and scratched; there were old scratches on it, showing its previous contact with steamers' bottoms. It was shaped like a flatiron, firmly bedded in hardpan, with the sharp, pointed end standing up. It was the ugliest natural vessel destroyer ever seen.

You may ask why did not the lake survey engineers find this rock? I answer, that following the usual plan in sounding rivers, by straight and diagonal lines, from bank to bank, with a lead line, it was not surprising they missed it. In that swift current it would be impossible to run straight lines. The boat would invariably sag, or, in other words, curved lines would be sounded. Of course, when these lines were plotted on paper as right lines they would be faulty. Moreover, the usual way of sounding may do for bays, lakes and quiet streams, but where the current is swift and the bottom rocky, some better way must be found to insure accuracy.



THE SEWERAGE OF MEDINA, NEW YORK.

O. C. GILLETT.

The village of Medina, New York, is the location of the celebrated sandstone quarries. The corporation is about two miles square and contains five thousand people. It is divided into four parts by the Erie canal, extending east and west, and by the Oak Orchard creek, which runs from south to north. The surface slopes to the north and towards the creek. The creek, north of the canal, runs in a deep gorge. The rock lies quite near the surface, and renders it necessary to exercise great care in designing sewers so as to have them deep enough to answer the purpose, and not to entail unnecessary expense by going too deep in rock cutting. There were in the village two or three stone drains, with rubble walls, laid dry, and covered with flagging. These, in course of time, were made to do duty as sewers, instead of being restricted to their legitimate use as drains, and with the usual results. A large part of the village had no drainage at all, except onto the surface of the ground.

For a long time efforts have been made to get sewers built for the relief of some particular locality, but without success. In 1889 the legislature passed an act authorizing incorporated villages to appoint boards of sewer commissioners. There are five of these commissioners and they serve for five years without pay. They are not to be all of the same political party; one goes out each year. By a little management the board of trustees of the village of Medina was induced to appoint sewer commissioners under the act of 1889. The sewer commission is authorized to expend not to exceed one thousand dollars for sewer plans for the village. These plans must be submitted to the state board of health for their approval before they become effective. The state board of health sends an expert sanitary engineer to look the ground over with the plans in hand. Their action is based on his report.

cheaply, and there is this to be said, that so far as future plats are concerned, there need be no public expense any more than there is now in placing a plat on record. The law on plats might specify that a copy also be filed in the office of the county surveyor. And sure enough, why not?

EXPANSION OF AN AMPLITUDE.

H. C. PEARSONS.

Mr. President and Members of this Association:

Wishing to contribute my mite to our annual feast, I offer such as I can. My work being foreign to that of most engineers and surveyors, I have but a narrow choice of topics with which to entertain you. I offer the "Expansion of an Amplitude" for your consideration.

The finding of meridian, or azimuth, may, perhaps, be considered a subject somewhat trite in this fraternity, but a new method of utilizing an amplitude, by extending its availability from a few minutes to a few hours, may, perhaps, be worth a few minutes of your time.

We all know the value of an amplitude in finding direction, and we all know, too, how fleeting and short-lived is this valuable element to the surveyor. We have only time to get a glance at it, when it is gone—vanished.

But I have recently discovered a property in the rate of the change in sun's azimuth, that gives a great value to an amplitude, and that is a property of uniformity in the rate of the change of his azimuth, when the latitude and declination are of the same name, between sunrise, or sunset, and the time of his crossing the prime vertical.

Though this change is a function of both the latitude of the observer and the declination of the sun, the effect of declination on this change of azimuth, between the limits above mentioned, and above latitude, say 38°, is so small as to be inappreciable by any of our ordinary surveying instruments, *i. e.*, for all practical purposes of the surveyor, it may be called sub-

stantially uniform, though the rate of change increases slightly with the increase of latitude.

I use a table of time azimuths in orienting ship for compass errors, and I discovered on a number of times, when interpolating for the rate of change of azimuth, in early morning, or late afternoon, that this rate of change, between sunrise and prime vertical, and prime vertical and sunset, was uniform for all declinations in the same latitude. This led me to investigate the question, which I have done, with the results as above stated.

The following table gives the rate of the sun's change of azimuth, within the limits above specified, for a few parallels of latitude, to the nearest quarter minute, for one degree of change of azimuth:

Latitude.....	36°	38°	40°	42°	44°	46°	48°	50°	52°
Time for 1°.....	7m	6¾m	6½m	6m	6m	5¾m	5½m	5¼m	5m

An example will best illustrate the use of this table, showing the uniform rate of change:

Say a survey is to be commenced in latitude 43° N. when sun is in declination 21° 15′ N., as per Nautical Almanac. Compute sun's amplitude by the well known formula.

Sin. Amp. = sec. lat. × sin. dec.

Thus:

Sec. lat. 43°. — log. = 10.1359
Sin. dec. 21° 15′ " = 9.5592
Sin. amp. " 9.6951 = 29° 42′

Then, as each one degree of change of azimuth requires six minutes of time (see table), we have 179 minutes, or, say three hours of time, in which our amplitude is available for azimuth.

It is best to reduce the amplitude directly to azimuth, when we find the sun rises N. 60° 18′ E., and that it gains in azimuth one degree in each six minutes for three hours, thus giving ample time for determining the azimuth of some of the lines of the survey, whence other bearings may be had from the interjacent angles.

It must be remembered that, in consequence of refraction,

the sun shows himself before he is fairly up. The refraction being something over one-half degree, we must wait till his lower limb is fully one-half the sun's diameter above the horizon, before we take our bearing, as otherwise our line of reference will be too far to the left.

This caution being observed, we have nothing to do with "altitude" or "refraction" to know azimuth to a good degree of precision, quite sufficient for all the purposes of the practical surveyor. But the surveyor must be smart enough to get up before the sun, in order to note the time by watch when the sun rises. If we fail in this, we will incur the labor of some calculation. And if we wish to avail ourselves of this property in the afternoon, we will incur this calculation, any way.

Then, we must know the apparent time of sunrise, which must be deduced from mean local time and the equation of time. This will require a knowledge of the error of our watch on local time. It is best to get up early.

PROF. DAVIS: The title of this paper is the "Expansion of an Amplitude." I think Mr. Pearsons is a little unfortunate in his title. I think it should be "The extension of time for observing the sun for obtaining azimuth," and the paper covers this ground. Where it is possible for a surveyor to see the sun in the horizon at the time of rising, he may very readily get the direction of a line and thus his azimuth, near enough certainly for use with the needle compass, and very likely for the transit.

Now, I had no opportunity to prepare anything in addition to what Mr. Pearsons has to say or I would have gladly done so. He has given us here nothing but the result, which, presented in that brief way, is valuable, and gives no hint as to the amount of labor behind it.

MR. APPLETON: It would seem that there would be a good deal of labor behind that.

PROF. DAVIS: Wherever a surveyor can have a horizon, a large lake lying east of him for instance, he can make this observation very easily. It is easy enough to find the direction of the sun at sunrise.

MR. HODGMAN: That seems to be a very simple matter, then?

PROF. DAVIS: Why, it is a simple matter to use it. You have got to know just the direction at sunrise, and then allow for so much time to get your direction at a later hour.

MR. APPLETON: That is six minutes for every degree.

PROF. DAVIS: That is for this particular case. He gives a table showing that at 36 degrees of latitude it requires seven minutes to make a degree's difference in the direction of the sun, and that only gets to be six minutes from 36 until you get to 42 degrees of latitude. Where it is six minutes of time, it makes a degree difference between the sun's rise. Where you get to 56 degrees it takes five minutes of time to make a degree of difference in the direction of the sun.

COMPUTATION OF R. R. EARTH-WORK AND HAUL.

H. F. BEAN.

EARTH-WORK.

There are several methods of computing earth-work, and perhaps the most common is the average end area method, not that it is the most correct; but this method is easily applied, and in many cases is a close approximation to the true result.

FORMULA FOR AVERAGE END AREAS.

$$A = \frac{l}{2\times 27}(a^1 + b^1) \tag{1}$$

A = cubic yards, l = length of section in feet, a^1, b^1 = the areas in feet, of the two parallel ends of the section.

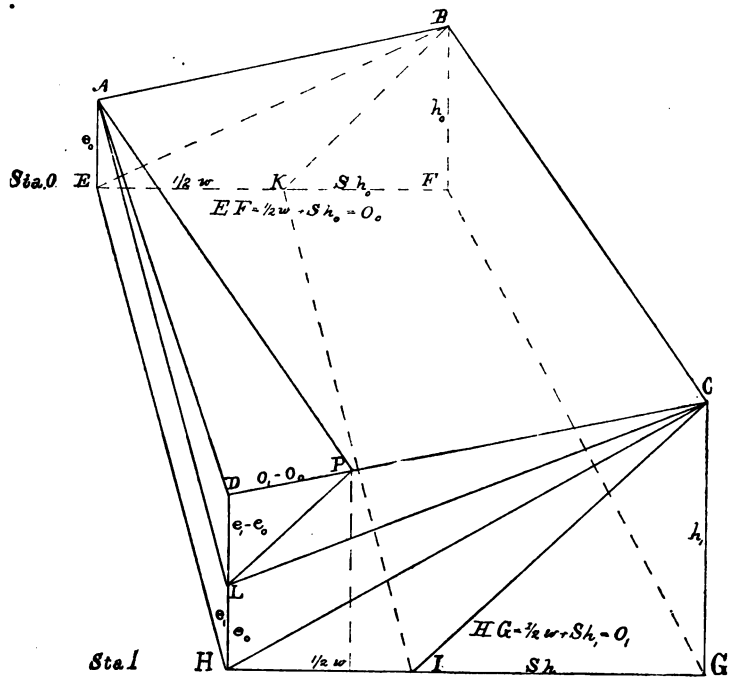
PRISMOIDAL FORMULA.

$$A = \frac{l}{6 \times 27}(a^1 + b^1 + 4m) \tag{2}$$

A = cubic yards, l = length of prismoid in feet, a^1, b^1 = the areas of the two parallel ends of the prismoid, and m is the area of the middle section parallel with the two ends.

In railroad work, the prismoid is composed of prisms, right

wedges, and pyramids, and as the prismoidal formula will give the true quantities of each separately, it must give the true amount in the prismoid. When $\frac{a^1+b^1}{2} = m$, it may be substituted for m in (2), and reduces to (1), therefore, when the middle area of the prismoid is equal to the half sum of the end areas, formula (1) gives the same result as formula (2).



In the prism and right wedge the half sum of their end areas is equal to their middle areas, and (1) or (2) give the same result. The case is different with the pyramid. In (1), let b^1 = area of the base of a pyramid, $a^1 = o$, and $A_1 = \frac{1}{2}l \times \frac{b^1}{27}$; but $A = \frac{1}{3}\, l \times \frac{b^1}{27}$ is the correct volume of the pyramid, the difference is $\frac{1}{6}\, l \times \frac{b^1}{27}$, which is the correction to be subtracted from the amount found by (1). $C = \frac{1}{6}\, l \times \frac{b^1}{27}$ (7) correction. The base and altitude of the triangle whose area is b^1, (base of pyramid) is found as follows: Let $A\ B\ K\ E$, Fig. 1, represent a cross section of the right half of a section of railroad excava-

tion, and $D\ C\ I\ H$ is another cross section l feet from the first.

Let e_0 and e_1 = center heights.
h_0 and h_1 = side heights.
w = width of roadway.
s = ratio of side slopes.
$o_0 = \frac{1}{2}\ w + s\ h_0 = E\ F$ = out of first.
$o_1 = \frac{1}{2}\ w + s\ h_1 = H\ G$ = out of second.
l = length of the section.

The question is to locate the pyramid, and find its base and altitude. Conceive a narrow plane to pass through the points H and C, along the lines $B\ C$ and $E\ H$, through the points B and E; the part cut off, $B\ E\ K - C\ H\ I$, is a triangular prismoid having one of its sides a rectangle ($E\ H\ I\ K$), and the middle area equals one-half the sum of the end areas, and can be computed by (1).

Take $H\ L = A\ E$, and draw the line $A\ L$, and conceive a plane to pass through the points C and L, along the lines $B\ C$ and $A\ L$, through the points A and B, cutting off the triangular prismoid $A\ B\ E - C\ H\ L$, whose side $A\ E\ H\ L$ is a rectangle by construction, and its middle area is one-half the sum of its end areas, and can be computed by (1). Take $M\ G = E\ F$, and erect a perpendicular at M, and produce it to P; draw the lines $A\ P$ and $P\ L$, and conceive a plane to pass through the points P and L, along the lines $A\ P$ and $A\ L$, cutting off the triangular prismoid $C\ P\ L - A\ B$, also the triangular pyramid $D\ P\ L - A$. The prismoid $C\ P\ L - A\ B$ is equal in volume to a right wedge, the area of whose base equals the area of the triangle $C\ P\ L$, and width equal to $E\ F$. Area of $C\ P\ L$ = area $C\ D\ L$ — area of $P\ D\ L$; area of $C\ D\ L = \frac{D\ L \times G\ H}{2} = \frac{(e_1 - e_0) \times O_1}{2}$, and area of $P\ D\ L = \frac{H\ M \times D\ L}{2} = \frac{(e_1 - e_0)\ (O_1 - O_0)}{2}$. By subtraction $C\ P\ L = \frac{(e_1 - e_0)\ O_0}{2}$. The middle area of the prismoid $C\ P\ L - A\ B$, is equal to the half sum of the two end areas, and can be computed by (1). The pyramid $P\ D\ L - A$ has for the area of its base the area of the triangle $P\ D\ L = \frac{(e_1 - e_0)\ (O_1 - O_0)}{2} = b^1$ in (7). Substitute the value of b^1 in (7), and we have:

(3) $$C = \frac{l}{2 \times 27} \frac{(e_1 - e_o)(O_1 - O_o)}{6}$$

Let $\frac{(e_1 - e_o)(O_1 - O_o)}{6} = e^1$, then (4) $C = \frac{l}{2 \times 27} \times e^1$.

$(1) - (4) = A_1 - C = A = \frac{l}{2 \times 27}(a^1 + b^1 - e^1)$.

(5) $$A = \frac{l}{2 \times 27}(a^1 + b^1 - e^1)$$

Formula (5) will give the same result as (2). For level cuts and fills, Fig. 1, $h_o = e_o$, and $h_1 = e_1$, $O_o = \frac{1}{2} w + s\, e_o$, and $O_1 = \frac{1}{2} w + s\, e_1$. $O_1 - O_o = (e_1 - e_o)\, s$, which multiplied by two, for both sides, gives $2\,(O_1 - O_o) = 2\, s\, (e_1 - e_o)$, and substituted in (3) for $(O_1 - O_o)$, then—

$$C = \frac{l}{2 \times 27} \frac{(e_1 - e_o)^2}{6} \times 2s = (6)\ C = \frac{l}{2 \times 27} \frac{(e_1 - e_o)^2}{3} s.$$

When the slope is $1\frac{1}{2}$ to 1, $s = 1\frac{1}{2}$, which substituted for s in (6), will give $C = \frac{l}{2 \times 27} \frac{(e_1 - e_o)^2}{2}$, or the factor $\frac{(e_1 - e_o)^2}{2} = e^1$, may be substituted in (5), and give the same result as (1) — (6).

The correction for three level work, center and side heights, is found as follows:

In (3), let O_1 and O_o, each represent the sum of the outs of either end (distance between the slope stakes on top of the cuts, or bottom of the fills).

For five level work, where the levels are taken at the center, foot of the slope (which is distant from the center in cuts, one-half the width of the roadway), and at the outside slope stakes.

In Fig. 1, let h^1 = height at foot of slope at (K), and h^{11} = height at foot of slope (not marked) at (I), then substitute $(h^{11} - h^1)$ for $(e_1 - e_o)$, in (3), will give the correction for one-half of the section, and the other half of the section is corrected in the same manner.

It is generally understood that no formula can be made that will give correct results, where the earthwork has not been properly cross-sectioned. The error of the average end area method may be reduced by taking several cross-sections in each section.

Let n = the number of sub-sections of equal length made from a section l feet in length; then $\frac{1}{n}$ = the fractional part of a section whose length is l, that is represented by the sub-

section. The length in feet of the sub-section is $\frac{1}{n} \times l = \frac{l}{n}$, which substituted in (6) for l (remember that $(e' - e_o)$ decreases in the same ratio as l decreases), and $C_1 = \frac{1}{n^3}\left[\frac{l}{2 \times 27}\frac{(e_1 - e_o)^2}{3}\right]s$, or $C_1 = \frac{1}{n^3} \times C$. But C is the correction for l feet, and $C \times \left[\frac{1}{n}\right]^3 = C_1$, the correction for one sub-section whose length is $\frac{l}{n}$ feet, and as the correction for each sub-section is the same, the correction for n sub-sections is $C \times \left[\frac{1}{n}\right] \times n = C \times \left[\frac{1}{n}\right]^2 = C_n$. Therefore, we conclude that if any section of earth-work is subdivided into n equal sub-sections, the pyramid correction (error by end area method) decreases in the ratio of C, to $C \times \left[\frac{1}{n}\right]^2$, or 1 to $\left[\frac{1}{n}\right]^2$. Assume $n = 4$, then $\frac{1}{n} = \frac{1}{4}$, and $(\frac{1}{4})^2 = \frac{1}{16}$, which has eliminated $\frac{15}{16}$ of the error, and if we put $n = 10$, then $\frac{1}{n} = \frac{1}{10}$, and $(\frac{1}{10})^2 = \frac{1}{100}$, or, we have eliminated $\frac{99}{100}$ of the correction (error), so that where the ground is irregular, we not only get a better average of the general surface of the ground, by taking cross sections where the surface of the ground changes; but we nearly eliminate the pyramid correction, and the average end areas will give a result not far from the truth.

Formula (1) is approved by statute to be used upon the public works of the state of New York. When the ridges or hollows run obliquely to the line of roadway, their direction should be marked in the field notes, so that the actual middle area can be calculated, and the prismoid calculated by formula (2). For an exposition of a method used by some, which consists of finding the areas of irregular cross sections and reducing them to level cross sections and applying the prismoidal formula, see Henck's Field Book, pages 109 and 110.

The three following examples will illustrate the method of applying the correction formula. In said examples I have assumed the roadway 20 feet wide with side slopes of $1\frac{1}{2}$ to 1.

The first is level cuttings, second three levels, and the third five levels, all sections 100 feet.

Ex. 1. $\frac{4}{16}$ $\frac{4}{0}$ $\frac{4}{16}$ area $a^1 = 104$.

$\frac{28}{28}$ $\frac{2}{0}$ $\frac{28}{28}$ area $b^1 = 456$.

In (4) $e^1 = \frac{(e_1 e_0)(O_1 O_0)}{6}$.

$$e^1 = \frac{(12-4)(28+28-16-16)}{6}.$$

$$e^1 = 32.$$

(5) $A = (a^1 + b^1 - e^1) \times \frac{l}{2 \times 27}$, $A = \frac{(104+456-32)}{2 \times 27} \times 100 = 977\frac{7}{10}$ cu. yds.

Ex. 3. $\frac{4}{16}$ $\frac{5}{10}$ $\frac{7}{10}$ $\frac{9}{10}$ $\frac{18}{28}$ area $= 236 = a^1$.

$\frac{8}{22}$ $\frac{9}{10}$ $\frac{11}{10}$ $\frac{18}{10}$ $\frac{18}{27}$ area $= 449.5 = b^1$.

In (4) $e^1 = \frac{(22-16)(9-5)+(37-28)(13-9)}{6} = \frac{6 \times 4 + 9 \times 4}{6} = 10.$

(5) $A = \frac{l}{2 \times 27}(a^1 + b^1 - e^1) = \frac{(236+449.5-10)}{2 \times 27} \times 100 = 1250\frac{9}{10}$ yds.

Ex. 2. $\frac{4}{16}$ $\frac{6}{0}$ $\frac{8}{28}$ area $174 = a^1$.

$\frac{10}{25}$ $\frac{12}{0}$ $\frac{14}{81}$ area $456 = b^1$.

In (4) $e^1 = \frac{(12-6)(31+25-16-22)}{6} = \frac{6 \times 18}{6} = 18.$

(5) $A = \frac{l}{2 \times 27}(a^1 + b^1 - e^1) = \frac{(174+456-18)}{2 \times 27} \times 100 = 1{,}133\frac{8}{10}$ yds.

Tables for calculating earth-work are a great saving of time and labor; besides in practice being less liable to error than computing by formula. About twenty years ago I computed an earth-work table which can be used for any slope or base, also for side hill cuts, or fills, ditches, barrow pits, etc.

BEAN'S GENERAL EARTH-WORK TABLE.

Form of the table.—Fig. 2.

Feet.	1	2	3	4	5	6	7	8	9
	Cubic yards.	Cubic yards.	Cubic yards.	Cubic yards.	Cubic yards.	Cubic yards.	Cubic yards.	Cubic yards.	Cubic yards.
10	9.26	18.52	27.78	37.04	46.30	55.56	64.81	74.07	83.33
20	18.52	37.04	55.56	74.07	92.59	111.11	129.63	148.15	166 67
30	27.78	55.56	83.33	111.11	138.89	166.67	194.44	222.22	250.00
40	37.04	74.07	111.11	148.15	185.19	222.22	259.26	296.30	333.33
50	46.30	92.59	138.89	185.19	231.48	277.78	324.07	370.37	416.67
60	55.56	111.11	166.67	222.22	277.78	333.33	388.89	444.44	500.00
70	64.81	129.63	194.44	259.26	324.07	388.89	453.70	518.52	583.33
80	74.07	148.15	222.22	296.30	370.37	444.44	518.52	592.59	666.67
90	83.33	166.67	250.00	333.33	416.67	500.00	583.33	666.67	750.00
100	92.59	185.19	277.78	370.37	462.96	555.56	648.15	740.74	833.33

The formula from which the table may be computed is found as follows:

In the triangle $B\ E\ F$, Fig. 1, assume $B\ F = C\ G$, and $E\ K = H\ I$ (by construction), then $B\ E\ K - C\ H\ I$ represents

a triangular prism, whose length is l, and volume in cubic yards will $= \frac{EK \times BF \times l}{2 \times 27}$. Let $EK = x$, and $BF = y$, also $\frac{1}{2} l = 50$ feet, and A = cubic yards in prism (8) $A = (x \times y) \frac{50}{2 \times 27}$, which is the formula required. Let $x = 10$, and $y = 1, 2, 3$, etc., which substituted in (8) will give the cubic yards opposite 10, and under 1, 2, 3, etc., in table, Fig. 2. Again substitute 20 for x, and 1, 2, 3, etc., for y as before, and the cubic yards will be found opposite 20, and under 1, 2, 3, etc.

The table gives the volume in cubic yards for triangular prisms whose lengths are 50 feet, and the base of the prism will be found in the first column under *feet*, and the altitude of its base, is found at the top marked 1, 2, 3, etc., and the cubic yards are found opposite the base, and under the altitude of the triangular base, which is given.

The table may be used for greater or less bases, or altitudes, by changing the decimal point. In the table, Fig. 2, I have given the cubic yards for bases, 10 feet, 20 feet, etc., merely to show how it is constructed; but in my table the first column under feet, commences with $\frac{1}{10}$, $\frac{2}{10}$, $\frac{3}{10}$ of a foot, and is carried to 50 feet, and the figures at the top of the table are 1, 2, etc., to 20 feet. This table has been used for several years by the M. C. R. R. Co., and they say that it fills the bill.

Example 3, calculated by tables.

$\frac{4}{16}\ \frac{5}{10}\ \frac{7}{0}\ \frac{9}{10}\ \frac{13}{28}$.
$\frac{8}{23}\ \frac{9}{10}\ \frac{11}{0}\ \frac{13}{10}\ \frac{18}{17}$.

By table, Fig. 2.	By large table, the amounts are taken direct for each prism.
$16 \times 5 =$ 46.3	74.1
27.7	
$28 \times 9 =$ 166.7	233.3
66.7	
$20 \times 7 =$ 129.6	129.6
437.0	437.0
$22 \times 9 =$ 166.7	183.3
16.7	
$37 \times 13 =$ 277.8	445.4
64.8	
83.3	
19.4	
$20 \times 11 =$ 185.2	
18.5	203.7
832.4	832.4
437.0	
1269.4	
-18.5 = correction	
1250.9 yards.	

Correction. $\frac{(22-16)(9-5)+(37-28)(13-9)}{3}$ or $\frac{6\times 4+9\times 4}{3}$ $= 2\times 4+3\times 4=5\times 4$.

Look in table for $5\times 4=\frac{50\times 4}{10}=18.5$ yards, which is the correction. If we computed the area of the first cross section the factors would be $\frac{16\times 5+28\times 9+20\times 7}{2}$, and we use the same factors to find the cubic yards by the table, only we do not divide by 2, as we use $\frac{l}{2}=50$ feet $=\frac{1}{2}$ (areas of the same) $\times$ 100.

PROF. COOLEY: Isn't it a fact that the contractor should measure by the average end area method?

MR. BEAN: In the state of New York that is the case. There was some difficulty about canal work and Mr. Hyde said that that was the way they measured it and that was their law there, but the supposition is that the end area method always favors the contractor, but the end area method does not differ so much, only where you have irregular work it is a hard matter to apply the formula. You help the matter by putting the cross sections close together, but no matter if these surfaces are plane, they will give the same value.

PRESIDENT: It is customary on many railroads to state in the specifications not only how the earth-work shall be computed, but as you are all very familiar with the fact that it is frequently stated in the specifications how far the haul shall extend. On the Detroit & Lansing road, in this State (I am sorry Mr. Tuthill is not here to tell us a little more definitely about it), but I think on that road that has been carried to the extent of saying that no haul will be allowed within 1,000 feet from the mouth of the cut. That would require a fill 2,000 feet long before they began any haul.

Are there any other points that you would like to present upon this subject?

MR. BEAN: Just one point in reference to the double track cross section. That is the kind of work that engineers hate, this double track work. Here is an irregular ditch. Want to cross section this—take out more earth or fill it up. Supposing we commence here, [drawing diagram on the blackboard;]

here is the line of level and we will just take a bend in here and draw a tape over here, and just take those levels and give the difference here. Here is the bank up here, and draw a line over here. Now the supposition is that the surface of the ground is something in that shape. Now in my table I compute two of these together. I have the heights and add them together and multiply with this width. If it is the same height, why all right. But supposing you are down here, then this triangle will be subtracted. It is not a very pleasing thing to work out, but you can work it out very well with the table.

PRESIDENT DAVIS: It is a gratification to have one's experience sustained by that of another man. I came to the conclusion that the only table of much use was the multiplication table.

MR. BEAN: When I was an engineer I didn't favor the haul question so much, but when I was a contractor I did favor it and was always willing to get all the haul I could. I know of no place where the rule of "thumb" is used so much as in the question of haul. The same individual hardly ever computes it twice alike himself. I will give you my theory and principle of doing it.

HAUL.

It is generally agreed between the company and contractor, that all earth hauled within a certain distance, which distance is called the limit of free haul, is paid for at a stipulated price, being included in the price paid for excavation, and for all earth hauled beyond that limit an additional price per yard for each 100 feet hauled will be paid. There is another limit of haul also, and that is when the price paid for the extreme haul equals the price paid for excavation, in which case the contractor is allowed to barrow and waste. The theory of calculating haul is not difficult; but in practice it is not so easy a matter. To find the points of free haul in excavation and embankment:

Let f = number of stations of free haul (100 feet each).

Select the points in cut and fill so that $(f - 1)$ stations of

the free haul nearly balance in excavation and embankment, with a difference of $\pm d$ yards of embankment.

Let x = additional distance to excavate the cut.
$100 - x$ = length of fill to balance the f stations.
m = cubic yards in one station of additional cut.
n = cubic yards in one station of additional fill.

$$\frac{m\,x}{100} = (100 - x)\,\frac{n}{100} \pm d.$$

$$x = \frac{100\,(n \pm d)}{m + n} \tag{9}$$

This is a close approximation, as x will be taken for the nearest whole feet. If an allowance for shrinkage or increase in excavation is required, change the value of m in (9). Assume that the excavation shrunk 10 %, substitute for m, in (9), $\frac{9}{10}\,m$.

The center of gravity formula seems to be the most correct principle for computing haul, and it is the only method that I shall discuss.

The prismoidal formula is based upon the assumption that the prismoid is composed of prisms, right wedges and pyramids, but it will give the correct volume of each separately; therefore, it will give the correct volume when two or more are taken together. I will make the same assumption in order to deduce the gravity formula, and must subdivide the prismoid into its prisms, right wedges and pyramids, and find the center of gravity of each, and from them the center of gravity of the prismoid.

Let A = cubic yards in a prismoid of earth.
P = cubic yards in its prisms.
W = cubic yards in its right wedges.
p = cubic yards in its pyramids.
H = center of gravity (haul) from the least cross section.
H_1 = center of gravity (haul) from the greater cross section.
l = length of prismoid (100 feet).

From mechanics we learn that center of gravity = $\frac{1}{2}\,l$ for the prism; $\frac{2}{3}\,l$ for the right wedge from edge, or $\frac{1}{3}\,l$ from base; $\frac{3}{4}\,l$ for pyramid from vertex, or $\frac{1}{4}\,l$ from base.

$$A = P + W + p.$$

$$H = \frac{\frac{1}{2} l \times P + \frac{2}{3} l \times W + \frac{3}{4} l \times p}{P + W + p} = \frac{l(\frac{1}{2} P + \frac{2}{3} W + \frac{3}{4} p)}{A}$$

$$H_1 = \frac{\frac{1}{2} l \times P + \frac{1}{3} l \times W + \frac{1}{4} l \times p}{P + W + p} = \frac{l(\frac{1}{2} P + \frac{1}{3} W + \frac{1}{4} p)}{A}$$

(10) $$H = \frac{l(\frac{1}{2} P + \frac{2}{3} W + \frac{3}{4} p)}{A}$$

(11) $$H_1 = \frac{l(\frac{1}{2} P + \frac{1}{3} W + \frac{1}{4} p)}{A}$$

Having given the cubic yards in a prismoid (A), to find the cubic yards in the prism (P), wedge (W), and pyramid (p), which compose the prismoid, and when substituted in (10), or (11), will give the center of gravity (haul) from either end of the prismoid. In (5) $A = \frac{l}{2 \times 27}(a^1 + b^1 - e^1) = \frac{l}{2 \times 27} \times a^1 + \frac{l}{2 \times 27} \times b^1 + \frac{l}{2 \times 27} \times -e^1$. Let $a = \frac{l}{2 \times 27} \times a^1$, $b = \frac{l}{2 \times 27} \times b^1$, and $-e = \frac{l}{2 \times 27} \times e^1$.

(12.) $A = a + b - e$, (volume in cubic yards). Assume $a = b$, the prismoid is a prism, and $e =$ zero. $A = a + a = 2a = P$, the prism. In (7) $\frac{1}{6} l \times \frac{b^1}{27}$ = correction; but $\frac{1}{3} l \times \frac{b^1}{27}$ = volume of pyramid, whose altitude is l feet, and area of base b^1 feet, therefore the correction is one-half of the pyramid, and $p = 2e$, $P = 2a$, and as $P + W + p = A$, $W = A - P - p$, or $W = A - 2a - 2e$. Substitute these values for P, W, and p, in (10) and (11) and reduce we have (13) and (14).

(13) $$H = l \frac{(A + b - e)}{3A},$$

which is the distance from center of gravity from the lesser cross section ($a < b$).

(14) $$H_1 = l \frac{(A + a - e)}{3A},$$

which is the distance of center of gravity from the greater cross section.

$$(13) + (14) = \frac{H + H_1}{2} = l \frac{(2A + a + b - e)}{6A} = l \frac{(3A)}{6A} = \frac{l}{2} \text{(19).}$$

$$(13) - (14) = \frac{H - H_1}{2} = l \frac{(A + b - \frac{1}{2} e - A - a + \frac{1}{2} e)}{6A} = l \frac{(b - a)}{6A} \text{(20).}$$

(15) $$H = l\left(\tfrac{1}{2} + \frac{b-a}{6A}\right)$$ by addition.

(16) $$H_1 = l\left(\tfrac{1}{2} + \frac{a-b}{6A}\right)$$ by subtraction.

(15) and (16) gave the average haul.

(17) $$H \times A = l\left(\tfrac{1}{2}A + \frac{b-a}{6}\right).$$

(18) $$H_1 \times A = l\left(\tfrac{1}{2}A + \frac{a-b}{6}\right).$$

(17) and (18) gives the entire haul to move the earth to either cross section.

In (12) $A = a + b - e$, remember that a and b represent the half volumes of prisms, and if $a = b$, and $e = o$, $A = 2a$, and $2b = P$; but the wedge is one-half the prism of the same altitude and base, then $\frac{1}{2} P = b$, volume of wedge, and as the pyramid equals one-third the volume of the prism of the same altitude and base, then $\frac{1}{3} \times P = \frac{1}{3} \times 2b =$ volume of pyramid.

In (15) $H = l\left(\frac{1}{2} + \frac{b-a}{6A}\right)$, let $a = b$, then $H = \frac{1}{2} l$ = center of gravity of prism. Let $a = o$, then the half prism b is a wedge, and $A = b$ which substituted in (15) for A gives $H = l\left(\frac{1}{2} + \frac{b}{6b}\right) = l\ (\frac{1}{2} + \frac{1}{6}) = \frac{2}{3} l$, or $\frac{1}{3} l$ in (16), which is the center of gravity of the right wedge. Again, for the pyramid $A = \frac{1}{3} \times P = \frac{1}{3} \times 2b = \frac{2}{3} b$, which substituted in (15) for A, gives $H = l\left(\frac{1}{2} + \frac{b}{4b}\right) = l\ (\frac{1}{2} + \frac{1}{4}) = \frac{3}{4} l$, or $\frac{1}{4} l$ in (16), which is the center of gravity of the pyramid, (15) and (16) fills the bill, because it gives the center of gravity of the prism, right wedge and pyramid, each separately, and must give the center of gravity of the prismoid. (13) and (14) will give the same result. (17) and (18) is the average haul multiplied by the number of yards and gives the total distance that one yard is hauled, and if l = one station (100 feet), the distance will be given in stations. Let l = one station, and let A, b and a, in cubic yards, be substituted in (17) and (18), and the result will be the number of yards hauled one station, or the number of stations one yard is hauled to move the earth in the section to either cross section. (13) and (14), $\frac{H + H_1}{2} = \frac{l}{2} = \frac{1}{2}$ sum.

$\frac{H - H_1}{2} = l\left[\frac{b - a}{6A}\right] = \frac{1}{2}$ difference.

In (19) $\frac{H + H_1}{2} = \frac{l}{2}$ = the sum of the distances of the center of gravity of the prismoid from each end (center of prismoid).

In (20) $\frac{H - H_1}{2} = l\frac{(b - a)}{6A}$ = the distance of the center of gravity from the middle cross section of the prismoid, and $\frac{l}{2} \pm l\left[\frac{b - a}{6A}\right]$ expresses the distance of the center of gravity from either end of the prismoid, and is given separately in (15) and (16).

In (12), $a = \frac{l}{2 \times 27} \times a^1$ in (1), and $b = \frac{l}{2 \times 27} \times b^1$, substitute these values for a, and b in (20) and reduce, which gives (21) $\frac{H - H_1}{2} = \frac{l^2(b^1 - a^1)}{12 \times 27 A}$. Again, if we substitute in (21) $A_1 = \frac{l}{2 \times 27}(a^1 + b^1)$, (1) for A, and reduce, we have (22), $\frac{H - H_1}{2} = \frac{l}{6}\left[\frac{b^1 - a^1}{a^1 + b^1}\right]$. Let $\frac{H - H_1}{2} = x$, and $A = s$, then (21) and (22) are identical with (360) and (361) in Searle's Field Engineering, page 244.

Now, (22) is a close approximation, but is not theoretically correct; because A_1, which was substituted for A, was obtained from (1). The correct value of A, given in (5), $A = \frac{l}{2 \times 27}(a^1 + b^1 - e^1)$, substituted in (21), gives the correct result in (23) $\frac{H - H_1}{2} = \frac{l}{6}\left[\frac{b^1 - a^1}{a^1 + b^1 - e^1}\right]$. Formula (23) expresses the distance of the center of gravity of a prismoid, from its middle section, in terms of its length, end areas, and end area correction. Formula (20) gives the same result, but a, b and A represent cubic yards, and may be taken from a table, or computed.

Formula (17) and (18) will give the distance to haul one yard, to be equivalent to hauling all of the earth to either cross section of a section of earth-work whose length is l. If $a < b$, and the earth is hauled toward a, use (17); but if hauled toward b, use (18).

A formula to compute the haul of several sections of earth work, or a whole cut or fill at once, is found as follows:

Let station $o = a_o =$ (area of cross section at station o) $\times \frac{100}{2 \times 27} = \frac{1}{2}$ vol.
" " $1 = a_1 = ($ " " " " " " " " 1) " "
" " $2 = a_2 = ($ " " " " " " " " 2) " "
" " $3 = a_3 = ($ " " " " " " " " 3) " "
" " $n = a_n = ($ " " " " " " " " n) " "

" " $A_1 =$ cubic yards in section 1.
" " $A_2 =$ " " " " 2.
" " $A_3 =$ " " " " 3.
" " $A_n =$ " " " " n.

" " $H_1 =$ haul of section 1, all earth hauled to station 1.
" " $H_2 =$ " " " 2, " " " " " " 2.
" " $H_3 =$ " " " 3, " " " " " " 3.
" " $H_n =$ " " " n, " " " " " " n.

" " $S_n^o =$ total haul of n sections hauled from 0, 1, 2, etc., to station n.
" " $l =$ 1 station = 100 feet.
" " $e_1 =$ correction of pyramid in section 1.
" " $e_2 =$ " " " " " 2.
" " $e_3 =$ " " " " " 3.
" " $e_n =$ " " " " " n.

Total haul of section 1, to station $n = H_1 \times A_1 + (n-1) A_1 = \frac{1}{2} A_1 + \frac{a_o - a_1}{6} + (n-1) A_1$.

Total haul of section 2, to station $n = H_2 \times A_2 + (n-2) A_2 = \frac{1}{2} A_2 + \frac{a_1 - a_2}{6} + (n-2) A_2$.

Total haul of section 3, to station $n = H_3 \times A_3 + (n-3) A_3 = \frac{1}{2} A_3 + \frac{a_2 - a_3}{6} + (n-3) A_3$.

Total haul of section $n-1$, to station $n = H_{n-1} \times A_{n-1} + (n - n + 1) A_{n-1} = \frac{1}{2} A_{n-1} + \frac{a_{n-2} - a_{n-1}}{6} + A_{n-1}$.

Total haul of section n, to station $n = H_n \times A_n + (n-n) A_n = \frac{1}{2} A_n + \frac{a_{n-1} - a_n}{6}$

By addition we have,

(24) $S_n^o = (n-1) A_1 + (n-2) A_2 + \ldots (n-n+1) A_{n-1} + \frac{1}{2} [(A_1 + A_2 + \ldots (n-n+1) A_{n-1} + A_n)] + \frac{a_o - a_n}{6}$.

(25) $S_n^o = (n - \frac{1}{2}) A_1 + (n - \frac{3}{2}) A_2 + \ldots (n - n + \frac{3}{2}) A_{n-1} + \frac{1}{2} A_n + \frac{a_o - a_n}{6}$.

Example 4.

Stations.	Cubic yards.	Cubic yards.	e	Cubic yards in stations.	
0	a_0				
1	a_1	$a_0 + a_1$	$-e_1$	A_1	A_1
2	a_2	$a_2 + a^1$	$-e_2$	A_2	$A_1 + A_2$
3	a_3	$a^3 + a_2$	$-e_3$	A_3	$A_1 + A_2 + A_3$
4	a_4	$a_4 + a_3$	$-e_4$	A_4	$A_1 + A_2 + A_3 + A_4$
$n-1$	a_{n-1}	$a_{n-1} + a_{n-2}$	$-e_{n-1}$	A_{n-1}	$A_1 + A_2 + \ldots\ldots A_{n-1}$
n	a_n	$a_n + a_{n-1}$	$-e_n$	A_n	

Example 5.

Stations.	Cubic yards.	Cubic yards.	e	Cubic yards in stations.	Haul (o to n) of whole sections.
0	200				
1	600	800	−10	790	790
2	1000	1600	−30	1570	2360
3	900	1900	−20	1880	4240
4	800	1700	−20	1680	5920
5	1200	2000	−30	1970	7890
6	1600	2800	−40	2760	
				2)10650	21200
	200	$\frac{1}{2}(A_1+A_2+..A_n)$		= 5325	5325
	−1600				26525
	6)−1400	$\frac{a_o - a_n}{6}$			−233⅓
	−233⅓				26291⅔ = yards hauled one station. Cost of haul at .01 per yard per station, $262.91⅔.
1	2	3	4	5	6

In example (5), assume station six to be the limit of free haul in excavation, the numbers represented in columns two, three, etc., marked at the bottom, the cubic yards tabulated as usual from cross section notes. Column five contains the cubic yards in each section, and 21200, the sum of column six, is the number of stations to haul one yard, which is equivalent to hauling the earth in section one, from station one to station six, hauling section two from station two to section six, etc., and may be calculated by the first part of (24), by substituting six for n, and we have $5\,A_1 + 4\,A_2 + \ldots . A_5$. One-half the sum of column five gives the number of stations to haul one

yard, to haul the earth in each station to either cross section, assuming that each section is hauled one-half station as shown in (24), $\frac{1}{2}(A_1 + A_2 + \ldots . A_n)$. Column two is used to make the correction for the assumption that the center of gravity lies in the middle cross section of each section, and is found in the last factor in (24), $\frac{a_o - a_n}{6} = \frac{200 - 1600}{6} = -233\frac{1}{3}$ cubic yards hauled one station, which is to be deducted from the haul calculated from the center of each section. When the factor in (24), $\frac{a_o - a_n}{6} = o$, there is no correction, as all intermediate cross sections have canceled, the haul computed from the middle of each section is correct. Here is where the utility of formula (24) lies, as we are not obliged to find the center of gravity of each section. Compute the haul from the middle of each section, and consider only the first and last cross section to make the correction, as shown in example (5).

Having computed the haul for the cut, the haul for the fill is computed in the same way, from the point of free haul in the embankment, the sum of the hauls of cut and fill is the total haul. It is no object to find the average haul in order to find the cost of haul; but it is found by dividing the total haul by the number of yards hauled. In the example given I took whole sections only, and this would never occur in practice; but I should first make the computation for all of the whole sections between the points of free haul and the extreme haul in both ends and fills, regardless of all plus stations, and then correct those plus sections by (17) if necessary. Having given the number of yards in a full section to find the number of yards in any of its sub-sections. In (12) $A = a + b - e$. I have shown that $P = 2a$, $p = 2e$, and $W = A - 2a - 2e$. Now, similar prisms are to each other as their length, similar wedges as the square of their lengths, and similar pyramids as the cube of their lengths. Let x = length of a prismoid that contains these solids, and let P, W and p represent their volumes. The volume for x feet in length of each, $P\,x$ = cubic yards in prism, $W\,x^2$ in wedge, and $p\,x^3$ in pyramid. Their sum = $P\,x + W\,x^2 + p\,x^3$ – (26) $A^1 = ((p \times x + W)\,x + P)\,x$. Take section one in example five, and find the number of yards in

forty feet off the smallest end of the section. Remember that x is the distance from the lesser cross section of the prismoid, and if x feet is required from the greater cross section, substitute $l - x$ for x. Let $x = \frac{40}{100} = \frac{4}{10}$ of a station in length, $a = 200$, $b = 600$, $e = 10$, and $A = 790$. Then $P = 2a = 400$, $p = 2e = 20$, and $W = 790 - 400 - 20 = 370$. Substitute these values in formula (26) $A^1 = 220\frac{1}{2}$ yards. This gives the volume without the cross section, and is very convenient to find the number of yards in the sub-sections adjacent the points of free haul in excavation and embankment, and the extreme limits of haul in the same.

In conclusion I wish to say that if any member of this society has a better method of calculating haul than this, I would be pleased to have him discuss it before the society, and have the method published, as I wish to be posted on the best practical method in use. This is a branch of calculation in engineering that most engineers dislike, and generally each one has a different method of computing haul, and what is still worse, they cannot compute it twice alike for the same problem.

PRESIDENT: I would say that Mr. Bean has here, in his equation No. 2, what may be designated as the Prismoidal Graphical process. From the bottom up, as Col. Muenscher says. Mr. Bean has arrived at it from the top down, and the part which interests me is the part which he has tabulated there. I want to see that in print, where I can work it over to my own satisfaction. I have been using a different method, a graphical method, easy to apply, if put on cross section paper, but I shall be glad to get hold of that and compare it with my graphical process, and I hope it is enough better so I shall be able to throw the graphical method into the waste basket.

There are a number of men in the room, familiar with this question. Should be glad to hear from you, gentlemen.

MR. BEAN: That little question of haul is easier in theory than in practice; especially when you are brought up in a big law suit and they want you to swear the haul is computed correctly.

COL. MUENSCHER: In our road we never have any contractors, and never have any law suits.

MR. TUTHILL: As far as I am concerned I have had but little experience. Mr. McVean practically eliminates that by saying all hauls shall be 1,500 feet from the mouth of the cut.

PRESIDENT DAVIS: The last time I heard from Mr. McVean it was only 1,000 feet. Present my compliments and say I think he will eliminate this difficulty.

MR. BEAN: My impression is that the easiest way to dispose of that question of haul, is to specify in the contract. It makes it easy for the engineer, but if he is a contractor he will look on the other side. Years ago, the way the work was let, they had a short free haul, and after that they were paid for haul, and of course you would be paid for excavation and embankment. If you haul cuts into fills, you make two yards for the company for every yard of cut hauled, and should be paid for it.

But here is another question. The railroad company reserves the right to change the grade. Now supposing you have a piece of work, and the profile shows you have 5,000 yards in excavation and 10,000 yards in fills, made from cuts and borrowed earth. The company reserves the right to change the grade. It is the easiest thing in the world to change the grade and increase the haul. But in the provision for haul, you should be paid for cut and fill, then if changes do occur, you will be protected. It is the only fair way to take contracts, but it is much easier for engineers to throw the haul out entirely.

EASEMENT CURVES.

E. W. MUENSCHER.

In a paper presented at the last meeting of this society, the writer described a method which he had devised for his own use for setting out an easement curve, and endeavored to show that by the simple expedient of adopting a uniform length of 200 feet for the curve, the formulas for calculating its elements become so simplified that any engineer who is capable of laying

out an ordinary circular curve can carry them in his head, and can apply them in laying out the easement without the use of any of the complicated tables which form an essential feature of all other methods which have fallen under his notice, and that thus what has heretofore been the most serious obstacle to the more general use of this very valuable expedient is practically removed.

This method, while professedly only approximately correct, is so nearly exact that for all cases where the curve to be flattened does not exceed 10° or 12°, the error is practically inappreciable. As this will cover fully ninety-nine cases out of one hundred that occur in practice, and as, for convenience in retracing these curves in the future, it is the best policy to use a uniform system throughout the entire length of a road, it would seem that there would seldom be occasion for the use of any more complicated method. To meet this one-hundredth case, however, and to provide for a very convenient application of easement curves in which a uniform length cannot be used, it is proposed to show in this paper that the principle of the method is general, and can, with but little sacrifice of accuracy and simplicity, be applied to easement curves of any length likely to be employed in practice. For this purpose it will be necessary to repeat a portion of the former paper, which will perhaps be the more excusable as it will serve to present the whole matter in a compact form.

Let l = length of easement curve in feet.
$\llcorner$ = " " " " " stations of 100 feet.
Δ = central angle of easement curve.
D = degree of curvature of central curve.
R = radius of central curve.
S = shift of central curve, or the distance it must be moved in toward the center.
X = the abscissa of any point on the easement curve.
Y = the ordinate " " " " " " "
O = " " " the terminal point (or $P\ C\ C$).
e = elevation in feet of the outer rail on the central curve.
i = distance in feet in which the outer rail rises one foot.

The initial point of the easement curve, or the point at which it leaves the tangent (which we will call the $P\ T\ C$), is taken as the origin, and the tangent produced as the axis of co-ordinates, *i. e.*, the abscissa, X, is measured from the $P\ T\ C$ along the tangent, and the corresponding ordinate, Y, is measured from the extremity of the abscissa at right angles to the tangent.

To express the properties of the form of curve which has been found to be best adapted to our purpose we take from Rankine's Civil Engineering the following formulas:

$$Y = \frac{4\ O\ X^3}{l^3} \tag{1}$$

$$\tfrac{1}{2}\ l = \sqrt{6\ O\ R} \tag{2}$$

$$S = \frac{l^2}{24\ R} \tag{3}$$

Combining equations (1) and (2) we obtain.

$$Y = \frac{X^3}{6\ l\ R} \tag{4}$$

and since when $y = O.$, $X = l$, very nearly, we have

$$O = \frac{l^2}{6\ R} \text{ evidently} = 4\ s. \tag{5}$$

We also have

$$R = \frac{5730}{D} \tag{6}$$

$$L = \frac{l}{100} \tag{7}$$

and

$$l = 100\ L. \tag{8}$$

In this form of curve one-half its length lies on each side of the original $P\ C$ of the central curve, and it is tangent at one end to the original tangent, and at the other to the shifted central curve. Hence it follows that the easement curve takes the place of one-half its own length of the central curve, its origin (or $P\ T\ C$) is at a distance from the original $P\ C$ equal to $\frac{1}{2}\ l$, and its central angle (or the angle between the tangents at its extremities), equals the central angle of half its length of the central curve. Hence we have

$$\Delta = \tfrac{1}{2}\ L\ D \quad (9) \quad = \tfrac{1}{2}\ D\ \frac{l}{100} \tag{10}$$

$$D = \frac{2\ \Delta}{L} \quad (11) \quad = \frac{200\ \Delta}{l} \tag{12}$$

$$L = \frac{2\ \Delta}{D}. \tag{13}$$

To express the proper relations between the length of the curve and the slope of the rail we have

$$l = e\ i. \tag{14}$$

In the former paper it was assumed that the maximum value of e in practice is $\frac{2}{3}$ feet, or 8 inches. This is the limit adopted by the Roadmasters' Association at one of its meetings, it is sufficient for a velocity of 50 miles per hour on a 5° curve, of 35 miles per hour on a 10° curve, and of 25 miles per hour on a 20° curve, and a prudent locomotive engineer would seldom venture to exceed these limits. The minimum value of i was taken at 300 feet (equivalent to one inch rise in 25 feet) as recommended by Rankine. Substituting these values in equation (14) we obtain

$$l = 200. \tag{15}$$

Substituting in equations (4), (5) and (3) the values of l in (15), and of R in (6), we obtain:

$$Y = \frac{X^3\ D}{6.876.000} \tag{16}$$

$$O = 1.164\ D \quad (= \tfrac{7}{6}\ D \text{ very nearly.}) \tag{17}$$

$$S = 0.291\ D. \tag{18}$$

From equation (16) it appears that the ordinates, or offsets from the tangent, to intermediate points of the curve are proportional to the cubes of the abscissas, the easement curve differing in this respect from a circular curve, in which, within moderate limits, the ordinates are as the squares of the abscissas as expressed by the formula:

$$y = \tfrac{1}{8}\ L^2\ D. \tag{19}$$

Hence, having O, from equation (17), these ordinates are easily calculated for all other points. Making the abscissa, or the value of X in equation (16), successively $\frac{1}{8}l$, $\frac{1}{4}l$, $\frac{3}{8}l$, $\frac{1}{2}l$, $\frac{5}{8}l$, $\frac{3}{4}l$, $\frac{7}{8}l$ and l, which gives points at intervals of 25 feet, we obtain the following table of the values of the offsets:

TABLE I.

Abscissa	$\frac{1}{8}l$ 25 ft.	$\frac{1}{4}l$ 50 ft.	$\frac{3}{8}l$ 75 ft.	$\frac{1}{2}l$ 100 ft.	$\frac{5}{8}l$ 125 ft.	$\frac{3}{4}l$ 150 ft.	$\frac{7}{8}l$ 175 ft.	l 200 ft.
Ordinate	$\frac{1}{512}O$	$\frac{8}{512}O$	$\frac{27}{512}O$	$\frac{64}{512}O$	$\frac{125}{512}O$	$\frac{216}{512}O$	$\frac{343}{512}O$	O
For $l = 200$	.00227 D	.018 D	.061 D	.145 D	.284 D	.491 D	.779 D	1.164 D
General	.00454 $\frac{\Delta}{L}$	.036 $\frac{\Delta}{L}$	.122 $\frac{\Delta}{L}$	.291 $\frac{\Delta}{L}$	.568 $\frac{\Delta}{L}$	.982 $\frac{\Delta}{L}$	1.558 $\frac{\Delta}{L}$	2.328 $\frac{\Delta}{L}$

These offsets are easily calculated in the field, and may be

used for setting out the curve, but are more useful for setting over the stakes of a line which has been already located in the usual manner, and into which it is desired to introduce an easement before the grading is done or the cross section stakes set, a case which may often occur. For this purpose the following table will be convenient, in which column four is calculated by equation (19) and column five is the difference between three and four:

TABLE II.

Distance of point from *P T C.*		Offset.			
		Tangent to easement.	Tangent to original line.	Original line to easement.	
1	2	3	4	5	6
$\frac{1}{8}\ l$	25 feet.	.00227 *D*	0.0	0.00227 *D*	$0.00454\frac{\Delta}{L}$
$\frac{1}{4}\ l$	50 "	.018 *D*	0.0	0.018 *D*	$0.036\frac{\Delta}{L}$
$\frac{3}{8}\ l$	75 "	.061 *D*	0.0	0.061 *D*	$0.123\frac{\Delta}{L}$
$\frac{1}{2}\ l$	100 "	.145 *D*	0.0	0.145 *D*	$0.291\frac{\Delta}{L}$
$\frac{5}{8}\ l$	125 "	.284 *D*	0.054 *D*	0.230 *D*	$0.460\frac{\Delta}{L}$
$\frac{3}{4}\ l$	150 "	.491 *D*	0.218 *D*	0.273 *D*	$0.546\frac{\Delta}{L}$
$\frac{7}{8}\ l$	175 "	.779 *D*	0.491 *D*	0.288 *D*	$0.576\frac{\Delta}{L}$
l	200 "	1.164 *D*	0.873 *D*	0.291 *D*	$0.582\frac{\Delta}{L}$

All other points on the central curve must be moved in 0.291 *D*, and it will be sufficiently correct for the grading to use 0.3 *D*, which is very easily remembered.

The easiest and best method of setting out the curve is by deflection angles with the transit. Supposing the transit setting at the *P T C* and calling the deflection angle from the tangent to any point on the curve $= a$, we have evidently

$$\text{Tang. } a = \frac{Y}{X} = \frac{X^3}{6\,l\,R} + X = \frac{X^2}{6\,l\,R} = \frac{X^2\,D}{3438\,l}. \qquad (20)$$

For the terminal point of the curve (or $P\ C\ C$) since $X = l$, very nearly, and $l = 200$, we have

$$\text{Tang. } a = .005817\ D. \tag{21}$$

$$a = 0°\ 20' \times D = \tfrac{1}{3} D°. \tag{22}$$

Since, when $l = 200$, equation (10) gives $\triangle = \left(\frac{1}{2}\ D \frac{l}{100}\right) = D$, the deflection from the chord to the tangent at the $P\ C\ C$ must be equal to $D - \frac{1}{3}\ D = \frac{2}{3}\ D$. From equation (20) it appears that tangent a varies as x^2 and D, and since, for such values of a as would be likely to occur in practice, an angle varies very nearly as its tangent, we may say without appreciable error that the deflection angle from the tangent at the $P\ T\ C$ to any point on the easement curve will vary directly as the degree of curvature of the central curve and as the square of the distance of the point from the $P\ T\ C$. By this principle we may very easily calculate in the field the deflections for intermediate points, and no table is essential, but a little time may sometimes be saved by the use of the following table of values of a:

TABLE III.

Distance of point from *P T C.*		Value of a, or deflection angle.									
		General.	$D = 1°$	$D = 2°$	$D = 3°$	$D = 4°$	$D = 5°$	$D = 6°$	$D = 8°$	$D = 10°$	$D = 12°$
$\frac{1}{8}\ l$	25 feet.	$\frac{1}{100}\ D°$	0° 15′	0° 30′	0° 45′	0° 1¼′	0° 1 9/16′	0° 1 7/8′	0° 2½′	0° 3⅛′	0° 3¾′
$\frac{1}{4}\ l$	50 "	$\frac{1}{400}\ D°$	0° 1¼′	0° 2½′	0° 3¾′	0° 5′	0° 6¼′	0° 7½′	0° 10′	0° 12½′	0° 15′
$\frac{3}{8}\ l$	75 "	$\frac{3}{900}\ D°$	0° 2 13/16′	0° 5⅝′	0° 8 7/16′	0° 11¼′	0° 14 1/16′	0° 16⅞′	0° 22½′	0° 28⅛′	0° 33¾′
$\frac{1}{2}\ l$	100 "	$\frac{1}{100}\ D°$	0° 5′	0° 10′	0° 15′	0° 20′	0° 25′	0° 30′	0° 40′	0° 50′	1° 0′
$\frac{5}{8}\ l$	125 "	$\frac{25}{1600}\ D°$	0° 7 13/16′	0° 15⅝′	0° 23 7/16′	0° 31¼′	0° 39 1/16′	0° 46⅞′	1° 2½′	1° 18⅛′	1° 33¾′
$\frac{3}{4}\ l$	150 "	$\frac{9}{1600}\ D°$	0° 11¼′	0° 22½′	0° 33¾′	0° 45′	0° 56¼′	1° 7½′	1° 30′	1° 52½′	2° 15′
$\frac{7}{8}\ l$	175 "	$\frac{49}{1600}\ D°$	0° 15 15/16′	0° 30⅞′	0° 45 13/16′	1° 1¼′	1° 16 9/16′	1° 31⅞′	2° 2½′	2° 33⅛′	3° 3¾′
l	200 "	$\frac{1}{8}\ D°$	0° 20′	0° 40′	1° 0′	1° 20′	1° 40′	2° 0′	2° 40′	3° 20′	4°

When the curve is to be set in from the *P C C* toward the *P T C* the necessary deflections are given in the following table:

TABLE IV.

Distance from P C C.	*Deflection angle.*
$\frac{1}{8}\ l = 25$ feet	$\frac{23}{192}\ D.$
$\frac{1}{4}\ l = 50$ "	$\frac{44}{192}\ D = 13\frac{3}{4}' \times D.$
$\frac{3}{8}\ l = 75$ "	$\frac{62}{192}\ D.$
$\frac{1}{2}\ l = 100$ "	$\frac{80}{192}\ D = \frac{5}{12}\ D.$
$\frac{5}{8}\ l = 125$ "	$\frac{95}{192}\ D.$
$\frac{3}{4}\ l = 150$ "	$\frac{108}{192}\ D = \frac{9}{16}\ D.$
$\frac{7}{8}\ l = 175$ "	$\frac{119}{192}\ D.$
$l = 200$ "	$\frac{128}{192}\ D = \frac{2}{3}\ D.$

As these deflections are not easily remembered or calculated except those for the 100 and 200 feet points ($\frac{5}{12}\ D°$ and $\frac{2}{3}\ D°$) it will be most convenient to set only these two points from the *P C C*, and any other necessary points from the *P T C*.

It sometimes happens that the *P T C* is inaccessible. In this case set up at the *P C*, 100 feet (or $\frac{1}{2}\ l$) farther forward on the tangent, deflect $\frac{2}{3}\ D°$ from the tangent measure 100 feet and set the *P C C*, then set at the *P C C* and deflect $\frac{1}{3}\ D°$ from the chord, which will give the tangent. If the *P C C* cannot be set from the *P T C*, we may use the above method, or we may first set the middle point of the easement curve, and then set the *P C C* from this point. The deflections will be the following, as may readily be deduced from Tables III and IV:

Transit at *P T C* vernier reading 0° on tangent.

Deflect $\frac{1}{12}\ D°$, vernier reading $\frac{1}{12}\ D°$, gives chord to middle point.

Transit at middle point on chord produced.

Deflect $\frac{2}{12}\ D°$, vernier reading $\frac{3}{12}\ D°$, gives tangent at middle point.

Deflect $\frac{4}{12}\ D°$, vernier reading $\frac{7}{12}\ D°$, gives chord to *P C C*.

Transit at *P C C* on chord produced.

Deflect $\frac{5}{12}\ D°$, vernier reading $D°$, gives tangent at *P C C*.

General Case.

We now propose to show that the principle obtained above is general, and may be applied to any length of easement curve within ordinary limits of practice.

In equations (5), (3), (20), (21) and (22), substitute the values of R, l and D from equations (6), (8) and (11) and we obtain

$$0 = 0.291\, L^2\, D. \quad (23) \quad = 0.582\, \text{L}\, \Delta. \tag{24}$$

$$S = 0.0727\, L^2\, D. \quad (25) \quad = 0.1454\, \text{L}\, \Delta. \tag{26}$$

$$\text{Tang. } a = \frac{X^2\, \Delta}{1719000\, \text{L}^2}. \tag{27}$$

$$\text{Tang. } a \text{ for } P\,C\,C = 0.005817\, \Delta. \tag{28}$$

$$a \text{ " } P\,C\,C = 0° 20' \times \Delta = \tfrac{1}{3}\, \Delta°. \tag{29}$$

These equations being precisely analogous to (17), (18), (20), (21) and (22) it follows that the same principle governs in both cases, and Tables I, II, III and IV, may be used for any length of curve, except that in Table I the first, third and fifth lines should be used, and in Table II the first and sixth columns, while in Tables III and IV the only change necessary is to substitute Δ for D. For convenience either in using these tables or in calculating them in the field, the curve should be divided into eight or four equal parts.

The difference between an easement curve of this form and a circular curve may now be very easily expressed. Supposing in each case the transit to be set at the origin of the curve, in a circular curve we deflect from the tangent $\frac{1}{2}$ the central angle to fix the other end of the curve, and at the other end deflect the remaining $\frac{1}{2}$, and the deflections to intermediate points on the curve vary as their distances from the origin. In the easement curve the deflection from the tangent at the origin to the other end is $\frac{1}{3}$ the central angle, and at the other end the remaining $\frac{2}{3}$ is turned, and the deflections to intermediate points vary as the squares of their distances from the origin. The easement curve is also twice as long as a circular curve for the same central angle.

The field work of setting out the easement curve in all ordinary cases may now be summed up in the following very simple rules, which are designed for a length of 200 feet, but by using the expressions in brackets they become of general application:

1. Find the apex and the intersection angle (I) of the tangents and the apex distance (T) in the usual manner. Then $T + 100$ will be the apex distance of the $P\,T\,C$. [$T + 50\, L$.]

2. Set transit at the *P T C* and deflect from the tangent $\frac{1}{12}$ $D°$ for the first chord of 100 feet, and $\frac{1}{3}$ $D°$ for the second. The latter fixes the *P C C*. [$\frac{1}{12}$ $\Delta°$ for $\frac{1}{2}l$, and $\frac{1}{3}\Delta°$ for l.]

3. Set at the *P C C* back sight to the *P T C*, and deflect $\frac{2}{3}$ $D°$. [$\frac{2}{3}$ $\Delta°$] This gives the tangent to the central curve.

4. Set out the central circular curve in the usual manner, making its angular length $= I - 2\ D°$. [$I - 2\ \Delta°$.]

5. At the end of the central curve (the second *P C C*) deflect from the tangent $\frac{5}{12}$ $D°$ for the first chord of 100 feet ($\frac{5}{12}$ $\Delta°$ for $\frac{l}{2}$) and $\frac{2}{3}$ $D°$ for the second ($\frac{2}{3}$ $\Delta°$ for l). This gives the second *P T C*.

6. Set at the *P T C*, back sight to the *P C C*, and deflect $\frac{1}{3}$ $D°$. [$\frac{1}{3}$ $\Delta°$.] This gives the tangent.

Any intermediate points for grading or for track laying may be set out by the tables or by calculating the deflections.

It may sometimes occur that it is desirable to move the central curve inward a given distance, or, in other words, to assume a value for *s*. It then becomes necessary to determine the other elements of the curve. Transposing equations (25) and (26), we obtain

$$l = 3.708 \sqrt{\frac{S}{D}} \tag{30}$$

$$\Delta = 1.854 \sqrt{S\,D} \tag{31}$$

We can then use tables III and IV as before.

By means of these formulas a very convenient and valuable application of the easement curve can be made in rectifying a location. When a located line consisting of a series of tangents and circular curves has been laid out over difficult ground, as for instance along a steep hillside, it will often be found upon an inspection of the profile that some portions of the line are satisfactory and should not be disturbed, while other portions can be improved by slight changes, as by moving a tangent or a curve in or out the same distance at each end, or more at one end than at the other, or inward at one end and out at the other. To modify the entire location to fit these changes might be a serious task, and perhaps introduce undesirable changes elsewhere, but where a tangent is moved out or a curve moved in, the connection between the severed portions of the line can be made with great ease and convenience by an ease-

ment curve. To do this find the point where the severed curve and tangent become parallel to each other, and measure the perpendicular distance between them at this point. This distance will be the value of s, which being substituted in equations (30) and (31) gives us $\llcorner$ and $\triangle$, and the point of parallelism on the tangent will correspond to the original $P\ C$, and the curve can then be set out as already directed. If the tangent or curve is to be moved parallel to itself a given distance, this distance will be the value of s. In other cases the point of parallelism can readily be obtained from the field notes of the first location, or by connecting the two lines at any convenient point and measuring the angles, from which the angular distance which the curve must be extended or shortened to bring it to the required parallelism may be readily calculated.

In conclusion the writer would most earnestly urge upon his brother engineers the constant use of easement curves in all cases of curvature exceeding 2°. It is a reproach to the profession that so effectual a remedy for the evils which it is intended to meet has been so long and so generally neglected. The writer must confess that for many years he was equally negligent with his brethren, and for no other reason than that no method of laying out an easement curve had come to his notice which did not appear so complicated and difficult to apply in the field that he was discouraged from attempting to use it. Since he stumbled, as it were, upon the very simple method which is described in this and the preceding paper he has never omitted to apply it, and with the most satisfactory results. His experience on a line of his own construction upon which this methed was adopted, over portions of which, almost a continuous succession of 8° and 10° curves, unballasted and but poorly surfaced, he has passed at 30 and 40 miles per hour so smoothly that, but for the elevation of the outer rail it could hardly be noticed that the train was passing onto or off from a curve, as compared with similar experiences on other roads well ballasted, in much better surface and with much lighter curvature, but where no easement curves were in use, where, when traveling at high speeds he has found much difficulty in keeping the coffee from flying out of his cup or himself from flying out of his chair, has convinced him beyond

a question of the great value of the easement curve, and that its general adoption would add greatly to the comfort of the traveling public, and save many a dollar to the treasuries of the railroad companies. It is true that however carefully an easement may be laid out it is liable to become somewhat distorted under the manipulations of the average track man, but the same thing is true of the most carefully laid out circular curve, and yet no respectable engineer would venture to claim that for this reason it is useless to take any care in the laying out of circular curves. And besides this, the track man, however careless, is obliged to keep somewhere near the center of the road bed, and if the easement has been put in before the road bed was graded, as it always should be, he cannot distort it very badly, and with his utmost efforts in this direction the line would still be better than the most perfect circular curve.

The writer does not pretend that these good results can be brought about only by the adoption of the method which he has described, for any other would answer a similar purpose, but he trusts that its extreme simplicity will commend it to engineers who are not expert mathematicians, or who do not feel justified in using the time of a locating party which is costing his employers thirty or forty dollars per day in splitting hairs.

Those who feel sufficient interest in the subject to pursue it further are referred to the writer's former paper in the Michigan Engineers' Annual for 1891, and the articles therein referred to, and especially to a very valuable article in No. 5 of "The Technograph" from the pen of Prof. A. N. Talbot, published since the writer's first paper was presented, in which similar general results are arrived at by an entirely different route, and the subject is treated in a much more thorough and scientific manner than the present writer, with his more moderate mathematical attainments, could attempt, though the great simplification of the formulas and practice which results from the adoption of a uniform length of 200 feet for the easement curve seems to have escaped the professor's notice.

FUNDAMENTAL PRINCIPLES OF THE CONSTRUCTION OF SURVEYING INSTRUMENTS.

L. BECKMANN.

In the construction of surveying instruments we aim to reach the desired result by the simplest way and combine the greatest strength with the least weight.

As a good foundation of a house is a guarantee of its safety and durability, so is the tripod on which we place the instruments a very important feature. As it is the base of the instrument it should be as firm and solid as is consistent with the least weight. The split leg tripod fills these requirements the best, and if we could separate the legs more and make them wider on top, as is done in the large tripods for plane tables, we would have a firmer base yet, but as this would reduce their portability we are restricted to the usual size.

Let us consider the transits first.

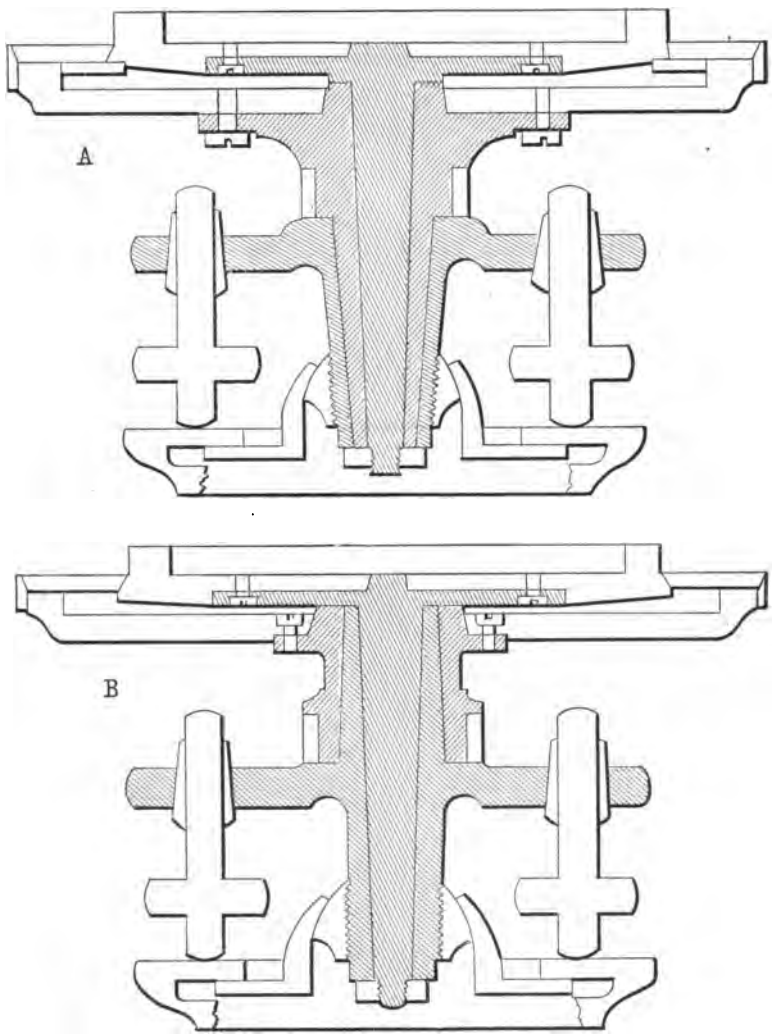
For the purpose of measuring horizontal angles we need an axis provided with means to bring it in a true vertical position. In small field instruments we obtain this vertical position by means of a ball and socket, fastened to the tripod head in a substantial manner, together with two pairs of opposing leveling screws. This ball and socket is now mostly made movable, as shifting tripod head, to bring the center of the instrument over the exact point from which we want to measure an angle.

In Germany and France they do away with the ball and socket, and make the field instruments the same as the larger instruments of the greatest accuracy are made here. The instrument stands direct with three leveling screws on the tripod, held down to the tripod by a hook provided with strong spiral spring. This way all undue strain to the center is avoided. But our American engineer would hardly like such an instrument, as he could not fold the legs together and shoulder the whole instrument, but he would have to take it carefully from the tripod, put it in its box and carry it to the

next point of observation, so this arrangement would not do for light field instruments. We might overcome the strain on the centers by placing them over the leveling head, as is seen yet in some old instruments, but the stability of the instrument is lessened this way to such a degree that we prefer to put the center through the ball and socket and bring it as near to the base as possible.

The center line of the ball and socket should always lie in the same plane with the seats of the leveling screws, so that when two opposite screws are loose, the ball should swing without moving the other two leveling screws from their seat, or these screws will get easily bent.

For the purpose of repeating the reading of angles, the center must be double, one outside carrying the limb circle, the other inner one carrying the vernier. These centers must be absolutely concentric, which concentricity is obtained by turning the centers between two firm points (dead centers) and by good workmanship. The vernier circle should have the same center as the limb circle, and most makers make them that way, both in this country and abroad. A few large firms however have lately adopted a different plan, probably caused by the test of the centers which is to arrest the vernier circle and turn the limb circle underneath. If the levels always remain in adjustment the centers must be concentric to each other. In this new construction the limb center is divided from the vernier center by a solid part of the leveling head so the outer or limb center may be turned without touching the vernier center.



For better illustration I have made two sketches of the different systems. Fig. A is the usual or old way, and Fig. B is the new or improved way.

The improvement is that the vernier plate has a center like a non-repeating instrument and the limb turns on the outside of it so the above level test cannot be made here as the vernier

center does not turn when the limb is turned, but what is gained here is lost in the accuracy of graduation, as they created two different and distinct centers for both limb and vernier. If these instruments are made very good they will stand a test that would seem absurd in the old style of construction. This test is to clamp limb and vernier together and set to zero and read both verniers. Now turn both limb and vernier together without touching upper clamp and tangent screw for 45°, 90°, etc., and see if the zero marks always remain together. But be particular that you change your position towards the instrument every time in taking each reading, that is, if you face N. and S. in the first reading, you have to face N. E. and S. W. in the second, E. and W. in the third, and so on. If the instrument had a little rough usage, or if the centers are worn ever so little, that it would make no conceivable difference in the old construction, the verniers will not read the same although the tangent screw is not touched and even you may find one position, perhaps N. and S., where the limb graduation seems to be perfectly concentric by turning the limb and not changing your position against the instrument. These errors are caused because the limb turns on one center and the vernier turns on another one.

The next important feature in transits is the firmness of all clamps and tangent screws, so the limb will not turn while the vernier is turned. To ascertain this a second telescope is sometimes fastened under the limb circle in large instruments.

For limb as well as vernier a clamp surrounding the center and leaving the limb plate perfectly free with a tangent screw working against a strong spiral spring seems to give the best satisfaction. The rims of the limb and vernier circle are mostly connected with the center parts by ribs running like radii to make them as light and strong as possible. The openings of the verniers should be large to admit plenty of light, and provided with an opaque shade. The graduation should be plain with sharp cut black marks, limb and vernier lying in the same plane and absolutely concentric.

The standards should be firm and strong, equidistant from the center and running parallel with the north and south lines of compass. Whenever no compass is needed it would be best

to cast both standards in one piece as is done in larger instruments for astronomical purposes.

The telescope must be at right angles to its axis, whose bearings must be adjustable to make the telescope swing truly vertical. Also for convenience of reversing, both ends of the telescope should swing over the compass box.

The telescope slide should be a perfect fit and the objective so fastened and truly centered that the line of collimation will not change in any position. If our American engineers could get used to the inverting telescope as our European brothers, we could have a more powerful telescope without increasing the present size. The telescope should give a clearly defined, bright view, with enough magnifying power to see objects 1,000 feet away. The extreme magnifying power is often a drawback, as it darkens the view to such a degree that in dark, misty days nothing can be seen.

As to the leveling instruments, most of what is said about the transits will also have reference to this class of instruments. In the first place, the base or tripod should be rather more firm yet than in transits, owing to the more sensitive level vial used in levels. The center should be strong and of sufficient length to be absolutely firm, it should be as near to the tripod head as possible. The level bar bearing the Ys should be strong and rigid, of hard metal to keep its shape under various conditions. The old way of separating the level bar from the center is objectionable because it increases the distance of the bar from the center; any looseness of center will be more perceptible and it causes frequent adjustment of the Ys. The closer the telescope to the axis and base of the instrument the firmer it will be; therefore, the Ys should be just high enough to let the telescope with level attached pass over the bar. The telescope itself should be evenly balanced on both sides of the Ys, so that if the telescope is focused for medium distance both ends should be equally heavy. The telescope should not be clamped too hard on the Ys, or it will wear the bearings and require frequent adjustment; its objective head should be light to overcome the unevenness of weight if focused for near and far. The rings upon which the telescope revolves should be of the hardest metal and of absolutely equal diameter.

In closing my remarks I will say that in constructing these instruments we have to confront two opposing factors. We want the greatest possible strength and firmness, combined with the least weight and greatest portability. To obtain this result the rule is, make as few parts as possible, a piece that can be cast in one is better than two pieces screwed together; the simpler the instrument, the fewer the adjustments, the better for the instrument.

PRESIDENT: Of course I cannot say that all the members are as much interested in this paper as I am. It interests me a great deal. There was one point he did not touch upon, which I have been hammering upon a good many years: The length of the transit axis.

Now suppose there is a little deviation in the position of the transit axis. If it is a short one, by so much is the line of sight the more readily turned out of place, so much more error there will be to the adjustment of the line of sight or the ranging of a straight line.

I see no reason why the limit of the length of the transit axis is not the outside diameter of the plate and I would like to have it made that long. I am also in favor of the three Ys.

Another thing I wish to emphasize, that I don't think Mr. Beckmann has put any too strongly, is the use of the inverting telescope. If we start the objective slide a little, we will have here a focus of seven inches. One may be ranging a line half a mile. You have got hold of seven inches of it. With an inverting telescope there will be no difficulty in placing the cross wires nearer the eye end of the telescope and getting a ten inch grip. That is one use of an inverting telescope. Put the cross wire ring back there; three-fourths of an inch is enough for the eye piece. I have such a telescope and if I break a cross wire all I do is to take out these two screws and put the cross hairs into my instrument without taking the ring out. I haven't got to fuss around again to put those cross wires in. I didn't take them out. But as we were to have this paper on elements of precision, perhaps that is a little out of order.

COL. MUENSCHER: You want the ring put close to the eye

end. One thing I would like to modify a little. The slow motion of the body of the instrument—the recognized use of the spring. The spring ought to be very strong, or there will be constant motion of the instrument. I have an old instrument and three or four years ago I had occasion to have it repaired, and sent it to Aloe at St. Louis, and he took out one of the pairs of screws and put in a spring, and I never have had any peace with that instrument since. The spring wasn't strong enough.

PRESIDENT: Mr. Beckmann will be glad to fix it for you, no doubt.

MR. STEELE: I feel that we are under obligations to the manufacturers of these fine instruments for coming here and representing their own work, and for sending work here for us to examine, and whatever we may say in regard to them, is done in a spirit of pleasant criticism, for their good, and for our own as well. I think that one of the important things that we have aimed at has been overdone. A light instrument has been attempted, and lightness in all its parts has for some years now been the aim of the manufacturer, and to some extent that has been carried too far. I think I am as lazy a man as any here, and would like to do as little work and get as big pay for it as I could at the same time, but I don't want to do the work over again. When it is once done, I want it done. Now I will call no names, but here is an instrument that you can judge from its general appearance is a fine one. It stands upon a tripod which has been attempted in the line of lightness, and as the maker supposed undoubtedly, strength also, but I consider it faulty, very much so. These pieces are all ash and are dug out on the inside, as you will see here, so that only the shell is left, not as thick as that pencil. These two ribs here are also carved out in various places to reduce their weight. The nuts that go upon these bolts are all loose. They are liable to come off whenever you are least expecting. That should be prevented, and it is done in this other instrument—the only one I have ever seen.

Now, it stands very much to reason that if we have a heavy instrument as this is, upon a light tripod, any strain will affect the instrument much more than as though we reverse those

conditions. This instrument will shake because there is not as much under it as there should be. Neither is the tripod strong enough to stand the rough usage of the field.

I have tried several instruments, and I have a small one now on a good solid tripod, and last summer it was used by a railroad engineer for a short time, and stood upon a sandy bank where the sun was pouring upon the bank and reflected upon the instrument, and staid there for two hours, and during all that use the very last sight, in coming back and testing each one, came on to the nail where it was first set off. In other words, the effect of the intense heat on that instrument had not changed anything at all. The engineer remarked that he could not do that with any instrument he had ever seen before. It occurred to me that the very fact that it was a light instrument was one reason it was not affected, less liable to be affected by the heat.

This instrument, however, will illustrate also what Mr. Beckmann has told you. You may take your magnifying glass and set at zero and turn it around, and you will find the other side is just one graduation off. You may try it a dozen times and find it so every time. That is a perfect illustration of what Mr. Beckmann has been showing us.

COL. MUENSCHER: That instrument seems to have the same defect Prof. Davis speaks of, having a very short axis. I suppose the shape the standard is put in is with the idea of making the standards steadier, but it seems to me it does not accomplish the object.

NOTES IN A ROLLING-MILL.

E. H. MUMFORD.

There is relatively little understood regarding the momentary work required to roll sheets and bars in the rolling-mill of today. I mean that, while experience has taught engineers the advisable amount of power to supply and the marginal excess of fly-wheel inertia, yet the actual work done on a given pass and the proportion in which this work is shared between

applied work on the material and neck friction of the rolls is still, so far as I know, a matter of conjecture.

The random notes I have been able to record here have been taken in a copper and brass mill, and I have thought it worth while to take a case in point in which the fracture of a "wabble connection" at an instant during the passage of a certain sheet of copper furnished data from which to estimate the conditions incident to doing a certain amount of work of this kind. The conditions were as follows: A sheet of copper eight feet wide and seven-eighths of an inch thick was being passed for the first time between rolls thirty-two inches in diameter and one hundred and twenty inches long. It had entered about eighteen inches when the connection above mentioned failed by twisting. The reduction in thickness averaged one-thirty-second of an inch. This and the compressive resistance of the sheet are doubtful data of the work, as the reduction was not exactly uniform the whole width of the sheet, and the temperature was only to be estimated by the appearance of the sheet, which was, apparently, at about the temperature, or degree of incandescence, at which a smith would work tool steel in the fire.

The conditions of the work being as above, a wabble of the section shown in the attached drawing was twisted short off at the face of a bolted flange from which it projected, no bending stress entering into the problem, and the plane of the fracture being, as nearly as possible, at right angles to the axis and presenting very uniform features on the face of the break. In calculating the strength of the twisted section I have used the usual formula:

$$M = \tfrac{\pi}{2} q, r^3 \qquad (1)$$

for the included circular portion, in which M represents the moment of torsion, q, the shearing resistance of the cast iron, and r, the radius of the circle included. For the parts of the section without this circular section, I have taken them as cut up into strips one-eighth of an inch wide and calculated their moments separately, using the formula:

$$\lesssim M = \lesssim q, a\, r \qquad (2)$$

in which a is the collective area of the four small strips of a common mean radius, r. The value of q, for this particular

case, I have determined by taking a test piece from the casting which failed and testing for tensile strength, f, in an Olsen machine. The result of four tests gave me average f equals 12800 pounds per square inch. The deduced value of q is

$$q = \tfrac{1000}{1350} f = \tfrac{1000}{1350} \times 12800 = 23680 \text{ pounds per square inch.}$$

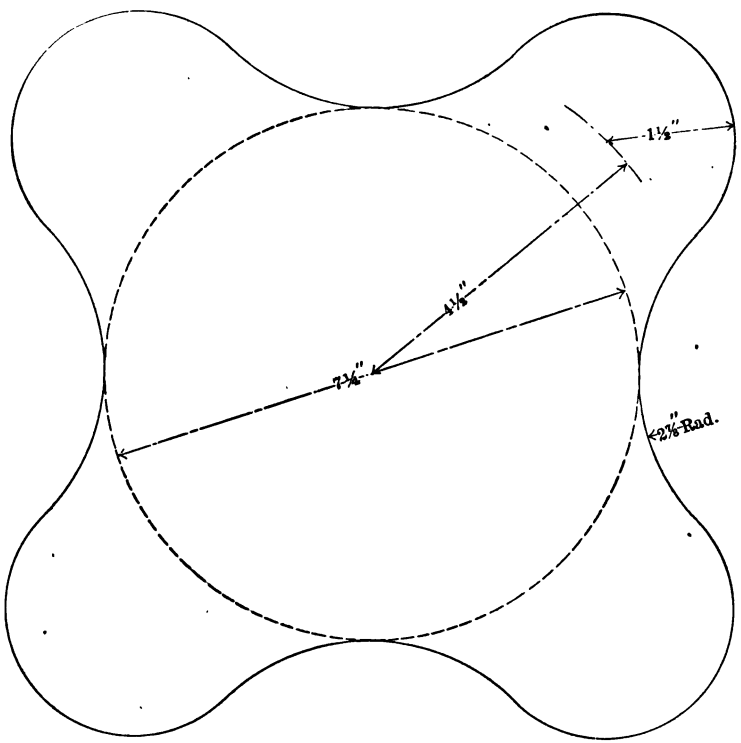
Substituting this value in (1) and (2), I have for (1):

$$M = 127701$$

and for (2):

$$M = 331900$$

giving a total of 459601 foot pounds of moment. I would explain the low value of f as partly due to the fact that the



test piece was taken from the body of a large casting and was, consequently, very "open" in its structure, but I deem it a fair average of the fractured section.

The velocity of rotation is 36 $R\ P\ M$ for the 32-inch rolls;

therefore the speed with which the sheet passes is $\frac{32\ \pi}{12} \times 36 =$ 302 feet per minute, assuming that the surfaces of the reduced sheet do not slide on the rolls. This implies that the thicker entering sheet is, as it were, held or pushed back, while its central portion is squeezed ahead at the velocity of the surface of the rolls. I have here a piece of brass wire, one-quarter of an inch wide and one-eighth of an inch thick originally, on which a pair of twenty-inch rolls have been allowed to stop in the process of reduction. The fibres of the wire, such as they are, have been etched into prominence by dilute nitric acid and have an interest in this connection. The curious darker portion is found at two places on the section, namely: at the point where the rolls ceased to act, and at the end where the shear cut it off, forcing the fibres to one side. As the dark appearance vanishes at a certain angle of reflected light, it may be supposed that there has been a new fibrous structure created by the action of the rolls, due, I would infer, to a longitudinal movement of the particles past one another. Any such action will take more prominence in a sheet in which the extension is almost entirely lengthwise, or in the direction of the pass.

Taking the crushing strength of cold cast copper at 100,000 pounds per square inch, and assuming that its malleability is rendered double by its temperature, and assuming 1-32 of an inch reduction, the vertical projection of contact with the rolls is approximately a strip 0.71 inches wide and 96 inches long, which gives as area in contact (that is in projection) and in vertical crush, 68.16 square inches and a total pressure of 3,408;000 pounds.

The reflections we are now led to are as follows:

We have a vertical pressure of 3,408,000 pounds acting equally on each of two 32 inch rolls at an arm of 0.355 inches to resist their turning. Expressed in foot pound moments this is

$$\frac{2 \times 0.355 \times 3408000}{12} = 201{,}640 \text{ foot pounds.}$$

leaving as a balance from the moment represented by the breaking of the wabble

$$459{,}601 - 201{,}640 = 257{,}961 \text{ ft. lbs.}$$

This must be sought in neck friction.

An expression for this is

$$M = 2\,f\,p\,r$$

in which f is the coefficient of friction, p the total load on one roll, and r the radius of the necks. That is

$$M = \frac{2 \times 10 \times 3{,}408{,}000}{12}$$

for necks, 20 inches in diameter.

$$i.\,e.\quad 257.961 = 5{,}680{,}000\,f$$
$$f = \frac{257961}{5680000} = 0.045 \text{ plus.}$$

We may expect to find an excessive load on the roll necks.

The weight of these rolls is, of course, very considerable, but may be neglected in comparison with the other load on the necks. Disregarding this, then, in the case of the bottom roll (the top roll is counterbalanced, but the rider brasses which support this roll add their frictional moment to the whole) the pressure per square inch of projected area is

$$\frac{3408000}{2 \times 13 \times 16} = 8192 \text{ lbs. per square inch.}$$

This is an abnormally great pressure, and we might expect a much higher coefficient of friction. We note, however, that the speed is very slow and that a sheet ten feet long would pass in two seconds, and then an ample interval for cooling and relubrication of the necks follows. In this nearly instantaneous action, it is not to be supposed that actual cutting would occur unless the elastic limit of the materials were exceeded. The lubricant used is, as might be supposed, the very thing for such exigencies, partaking, as it does, as much of the nature of Stockholm Tar as of oil. A heavy, pasty mass of it is packed all about the necks of the rolls and my experience with it would lead me to expect that the roll necks would rather behave themselves and keep cool than be treated to an additional dose.

This pressure, enormous as it is, amounting to 1700 tons and more, the weight of a good sized ship, is amply provided for in the massive housings which contain these rolls. These are of cast iron and have a section on either side of the neck of 264 square inches, a total section of four times 264 equals 1056 square inches. In my observation, these housings fail oftenest, owing, apparently, to a very slight change of form in the top or bottom portions joining the sides. It may occur to some of

my hearers that a rather extensive energy factory must be at the other end of the twisted wabble connection from the rolls; yet the engine is only 28x36 inches, taking 80-pound steam through a throttling governor, which wire-draws it down to a mean-effective of about thirty-five pounds on an average, and has other work to do on the other side of the shop, and a little hitching-strap in the shape of a twenty-inch belt to keep it from getting too light hearted. The influences that twisted this wabble are largely the inertiæ of various rotating pieces of mechanism enumerated as follows:

One 15-ft. fly wheel	80 *R P M*	energy equals	1174847	ft.	pounds.
One 14-ft. gear	36 *R P M*	" "	177792	"	"
One 6¼-ft. pinion	80 *R P M*	" "	89085	"	"
These rolls themselves		" "	10739	"	"
Connections driving rolls		" "	4514	"	"
Roll train on other side of engine		" "	2850	"	"
A grand total of.....			1459327	"	"

You will see in all this a tendency to keep things moving. In fact, give these reinforcements a chance to get into line of battle with that sheet, and, rather than give it up in two seconds, they would exert the power of more than thirteen hundred horses.

I may add that the wabble which failed is generally, as in this case, designed to be the weakest part of the mechanism, as it is expected that conditions will arise rendering it obligatory that something shall yield gracefully to the fabled resistless force and immovable obstacle.

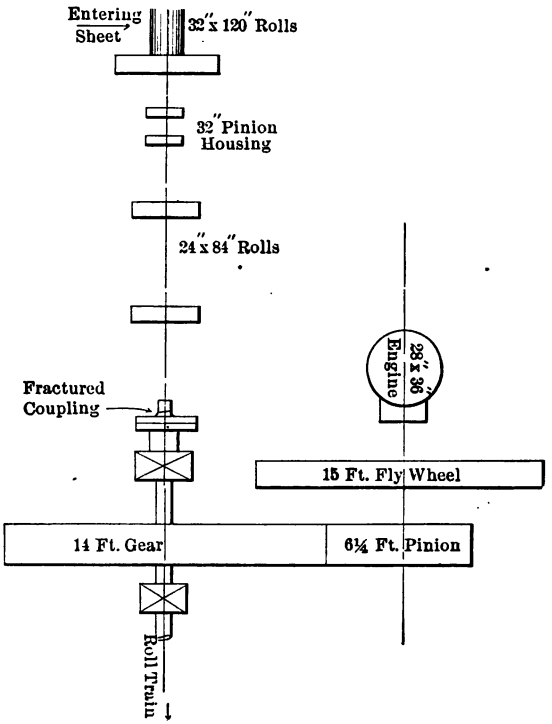
To more clearly explain the location of the part that failed, I append the attached diagram of the plan of the mill, as drawn on the blackboard at the time the paper was read.

I have a section of the casting with which I made the test, and a microscope and section of wire, that may be of interest. This wire was planed in two and the surface polished and the fibre is almost entirely at the middle of the wire.

There are curious things in connection with this process. The copper is always rolled while hot, and brass is never rolled hot. There is only one composition of brass that is rolled hot, and I think it is not generally known what it is.

PRESIDENT: Outside of the questions raised here, which are of interest to men engaged in mechanical pursuits exclu-

sively, of course there is a great deal brought forward of interest to us all in the matter of strength and resistance of materials, and it is possible the specimen there under the microscope would furnish some ideas with regard to the changes that take place in passing materials through the rollers and possibly raise some suggestions as to the injury or



benefit which metals receive from being treated in the rolling mill.

I am very sorry that we are not able to have the light of Prof. Cooley's countenance on this subject, for I think he would be glad to be here himself as well as for our benefit.

A paper of this character requires closest study, and office study, rather than study here, and it of course will appear in the proceedings, and gentlemen who wish to present anything further upon the same subject, will then have an opportunity of doing so.

THE ARCH: ITS ACTION.

CHAS. E. GREENE.

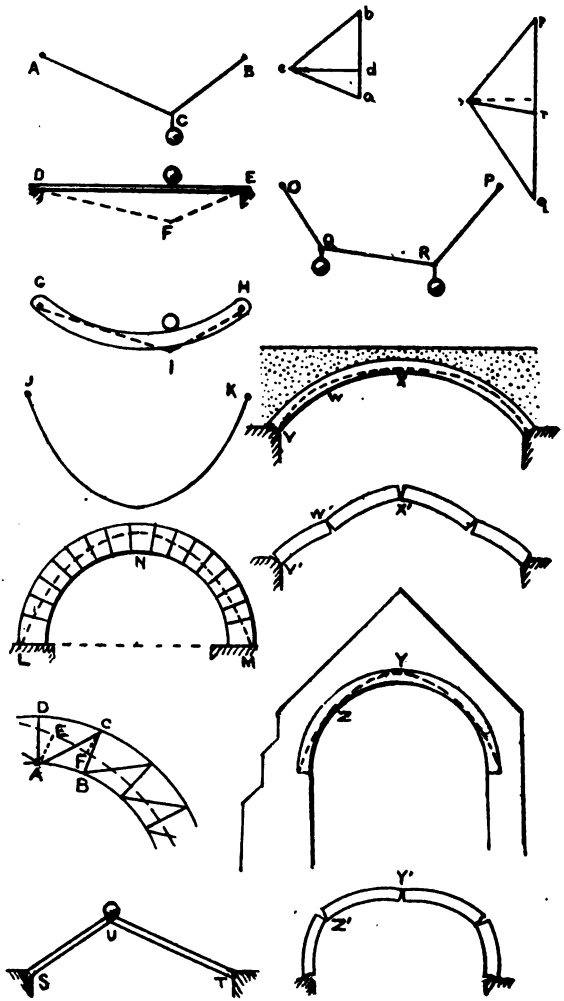
Since the arch in wood, in iron or in stone, is frequently used in construction, and since its analysis, as found in many books, is not very simple, the writer offers here a brief explanation of the action of an arch under a load, in the hope that the reader may get a clearer view of the matter, even if he may not be justified in attempting at once to calculate the strength and stability of such a structure.

By means of an arch an opening is spanned between two fixed points or abutments which keep the arch from spreading, and against which it therefore exerts a horizontal thrust. It may have a variety of outlines; in masonry the arc of a circle is most frequently employed. The centre line, midway between the exterior and the interior bounding curves, is usually assumed as the theoretical or skeleton arch.

Suppose that to two fixed points, A and B, in a horizontal line which represents the span, a string is attached and a weight suspended from the same at C, as in the first sketch. The string forms what is called an *equilibrium polygon*, which, in general, is the broken line assumed by a cord carrying one or more weights at different points, and hanging freely from two fixed points. See also $O\ Q\ R\ P$. If the weight is distributed continuously the polygon becomes a curve, as, for example, $J\ K$, which represents a hanging chain.

As is known to many, if a vertical line $b\ a$ is drawn to a scale to represent the weight at C in pounds, and $c\ a$ and $c\ b$, parallel to $C\ A$ and $C\ B$, are drawn from the extremities of the vertical line until they meet, these lines will, by the same scale, give the tension in pounds in the respective parts of the string to which they are parallel. The horizontal line $c\ d$ will be the measure of the force with which the two fixed points A and B are drawn towards one another.

If, in place of the string, a bar or rod $D\ E$ is put upon the


A
B
C
b
d
a
P
r
q
D
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F
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C
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two fixed points with the weight in the same position as before, the bar will have a tendency to assume the form *D F E* of the same equilibrium polygon. Its stiffness resists that tendency, and the vertical distance of each point of the bar above *D F E* is proportional to the bending moment at that point. Hence the greatest bending moment and the weakest point of a uniform bar is at the weight.

Again, if a curved bar *G H*, carrying the same weight, is substituted for the straight bar, this curve has the same tendency to assume the form *G I H*; one part tends to move down or out, and another part tends to move up or in; and here again, the vertical distance from the centre line of the bar to the lines representing the equilibrium polygon is proportional to the bending moment at each point.

Bend a moderately stiff wire into the arc of a circle, drill a hole through each end, as at *G* and *H*, by which to suspend it, and attach a sufficient weight at any point of the wire, so that the weight of the wire itself may be insignificant. When the strings are brought into such a position that a line joining the two holes is horizontal, and the distance between the two holes is the same as before the wire was hung up, these strings indicate the lines of action of the abutment forces and intersect upon the vertical line through the point of attachment of the weight. Imagine the apparatus inverted and we have the abutment thrusts, which have equal horizontal components, known as the horizontal thrust of the arch. In the triangle of forces, such as *a b c*, *b a* represents the weight by a scale of pounds to the inch, *c a* and *b c* the two abutment reactions, *c d* the horizontal thrust, and the bending moment in foot pounds at any point of the arch is equal to the vertical ordinate in feet from the centre line of the rib to the equilibrium polygon multiplied by the horizontal thrust in pounds.

The tendency thus far has been for the structure to move towards the equilibrium polygon. Suppose the polygon *A C B* to be inverted; two bars *S U T* must now be used. The force in each bar will plainly be thrust, given by a figure like *c b a*, and *c d* will be the horizontal thrust against the abutments. A straight bar on *S T* would tend to move away from this

polygon, as would also the curved bar *G H*, if erect like an arch. Turn the figure *G I H* upside down, and notice that the arch tends to move away from the equilibrium polygon at all points. Erect a bent wire so as to form an arch between two notches on a board or table, press the finger on the summit of the curve, and this action can be plainly seen.

The distances vertically from the equilibrium polygon to the centre line of the arched rib are still proportional to the bending moments, and the right equilibrium polygon, out of all those which might be drawn to intersect on the vertical line through the weight, is the one which has the value of *c d* in pounds the same as the horizontal thrust the arch would exert against its abutments when carrying the given weight *b a*. How to determine this thrust in a given case is beyond the limits of this article.

The weight of an arched ring of masonry of uniform thickness *L N M*, is distributed so nearly like that of the uniform chain *J K*, that the dotted equilibrium curve of *L N M* closely resembles *J K*. This arch therefore has its weakest points where the dotted curve deviates most from the centres of the joints, and, if the stones are so narrow that sensible movement occurs, the arch ring will descend at *N*, move outward at the haunches, and begin to revolve outwards at *L* and *M*. If the load were distributed uniformly per horizontal foot, the equilibrium curve would be a parabola, as in a suspension bridge cable, and such a curve inverted gives the best form of arch to carry such a load.

If a masonry arch, such as *V X*, is filled above with loose material to the horizontal line, the curve of equilibrium will resemble the one sketched in a dotted line. As the load is comparatively light at the crown, the haunch near *W* will tend to crowd in and the crown *X* will be forced up. At both points the movement is away from the equilibrium curve, and the failure will be like V^1 W^1 X^1. By making the arch ring broad enough to keep the equilibrium curve well within it, stability is assured.

In the example below the last, the load is excessive at the crown, *Z* and *Y* are the critical points, as shown by the dotted

line, and the arch ring, if too narrow, will fail like $Z^1\ Y^1$, coming down at the crown, even if the abutment is strengthened against yielding by buttresses, as on the left side.

If a metal rib like a truss is employed, the equilibrium curve is still useful. If $A\ B\ C\ D$ is one panel of such a rib, and $E\ F$ the equilibrium curve for a certain loading, the thrust in the piece $D\ C$ will equal the thrust in the equilibrium curve at E multiplied by $\frac{A\ E}{A\ D}$ while the thrust in $A\ B$ will equal that at F multiplied by the ratio $\frac{C\ F}{C\ B}$, the dotted lines to E and F being perpendiculars to the curve.

It is not difficult then, if one has a general idea of the location of the equilibrium curve, to determine the weak points in the arch, and to decide at what places the load may with advantage be increased or diminished. It is evident also that the addition of a moving load at X will improve the stability of that road arch, and that an increase of load in the road above W will decrease its stability. If the effects of the steady and moving loads at any point are of the same kind they are added, if of opposite kinds the difference is taken.

Some of the principal points have now been briefly sketched, in order to show why one arch will stand and why another will not. The abutments are supposed to be immovable; if they yield under the horizontal thrust, the arch is endangered, independently of other considerations.

The writer has applied this method of treatment in detail in that volume of his "Graphics" which discusses the arch.

THE DISPOSAL OF SEWAGE ON LAND,

With Particular Reference to Inland Villages and Isolated Buildings where Public Sewers are not Accessible.

GEO. S. PIERSON, M. AM. SOC. C. E., KALAMAZOO, MICH.

Our knowledge of the causes which influence the purification of sewage when applied to the soil has increased markedly during the past few years. It is still an open question, however, whether water which has been contaminated with sewage can be so thoroughly purified as to be entirely safe for culinary uses.

It is a matter of common knowledge that the purest of natural waters, so far as organic matter is concerned, are those which have undergone prolonged filtration through the soil. And it is well established that the purification of sewage by intermittent application to the soil is the most complete, and where the conditions are favorable, much the most desirable. In fact, it is not unusual to supplement chemical processes by subsequent filtration through the soil whereby the purification is carried to a higher degree.

The dangerous impurities with which sewage is charged consist mainly of different organic compounds in various stages of decomposition. It is not practicable, or in fact desirable, to prevent the decomposition of these organic compounds. With the exception of the small portion which may be consumed as food by animal life, they must be resolved into their elementary substances before they can again be utilized by plant life or otherwise rendered innocuous. It is practicable, however, to so control the conditions of decomposition that it shall not be offensive, and the resulting compounds shall be fixed and rendered harmless by some surrounding medium. The soil is a medium which not only renders these products innocuous but also favors a mechanical separation and aeration very conducive to the rapid disintegration of the putrescible matters contained in the sewage, and, where utilization is desirable, to their absorption as well.

In the report of the select committee on the Metropolis Sewage it is stated that:

"No efficient artificial method has been discovered to purify, for drinking and culinary purposes, water which has once been infected by town sewage. By no known mechanical or chemical means can such water be more than partially cleansed; it is always liable to putrefy again. Processes of filtering and deodorization cannot, therefore, be relied upon to do more than mitigate the evil. Water which appears perfectly pure to the eye is sufficient, under certain conditions, to breed serious epidemics in the population which drinks it. Soils, however, and the roots of growing plants have a great and rapid power of abstracting impurities from sewage water and rendering it again innocuous and free from contamination."

The process of purification of sewage by filtration through the soil is similar to that of burning up or oxidizing the organic matter leaving only a harmless mineral residue, which is soluble and passes off in the effluent, leaving the filtering medium, when properly managed, undiminished in efficiency. The application of sewage intermittently serves to increase the amount of oxidation similarly to opening the draft of a furnace.

The changes produced by wet oxidation, however, are not the same as those produced by heat, there being intermediate processes. In the former the nitrogen of the organic matter first combines with the hydrogen to produce ammonia which, upon uniting with oxygen, produces nitric acid. This, in turn, combines with potash, soda, lime or some other base present in the sewage or in the soil to produce a soluble nitrate. The extent to which this sequence of combinations has proceeded is a measure of the degree of purification of the sewage. The larger the amount of nitrates in the effluent, therefore, and the smaller the amount of ammonia, the more completely has the organic matter of the sewage been destroyed. Later investigations have shown that the earlier of these processes depend on the presence of living organisms.

This has been clearly established by exposing solutions of organic matter, in which the living organisms have been destroyed, freely to air filtered through cotton wool. Under these conditions no nitrification took place. Upon the introduction of a small quantity of soil or other medium containing these living organisms, however, they rapidly multiply and the purification proceeds.

It was formerly supposed that the oxidizing power of a soil depended solely on its porosity, being due to its contained oxygen. Later investigations have shown that a porous medium is not essential and that sewage may, indeed, be nitrified in a glass bottle or when passing over polished pebbles. Although it is proven that porosity is not essential it favors the rapidity of the nitrification in the soil by presenting an immense surface covered with oxidizing organisms and generally well supplied with air requisite for the continued discharge of their functions. In order to more fully illustrate this point the author made the following experiment:

Fifty cubic centimeters of ordinary screened mason's sand, of a fineness of 40 grains per lineal inch, were placed in a chemist's burette, having first been thoroughly freed from moisture by continued drying at a temperature of about 225°. Water was then introduced into the burette from below by aspiration, so as to facilitate the expulsion of contained air until the voids were entirely filled and the amount of water introduced carefully noted. The burette was then opened below and the excess of water over that naturally adhering to the particles of sand was allowed to drain off. From the facts noted the following computations were made:

The total air space in the dry soil was 36 per cent of the cubic contents. The water adhering to the particles of soil was 18 per cent of the cubic contents. The total superficial area of the particles of soil for each cubic foot was 2,200 square feet. The water adhering to the particles of soil for each foot in depth was equivalent to a film of water 1-1000 inches thick and 2,200 square feet in area. Since the purifying agencies within the soil and its contained air have been proved to be active to a depth of at least three feet we may assume that the surface of sewage which is exposed to the action of these purifying agencies is approximately 6,600 times greater when sewage is applied to the soil intermittently than when it is simply impounded over the same area.

The part which these organisms (bacteria) play in the destruction, or rather in the transformation, of the organic impurities of the sewage is stated so clearly and pertinently by T. Mitchell Prudden, M. D., in his book on "Drinking Water and Ice Supplies," that I quote his words as follows:

It has been found that if one starts with an artificial filter bed of perfectly clean sand, containing no bacteria, and floods it with dirty water the water which comes through for the first few days, and for a much longer time if the weather be cold, will be but little, if at all, purified. Its coarser suspended particles may have been caught in the sand pores, and so it may be clearer, but its dissolved organic matter and its bacteria may not be at all diminished. Indeed for some time, strange

as it may appear, the number of the bacteria may have largely increased. In fact, it appears that the pores of such a fresh sand-filter with the organic matter suspended in the water, form a most excellent breeding place for bacteria.

This seems discouraging, but let the experiment go on, and after a while if the dirty water has not been forced through the sand too fast, it will be found that the number of living germs which come out in the water at the bottom is growing steadily smaller and finally the water may be nearly or quite germ free. Now, if the chemist exposes some of the filtered water to his delicate tests he may find that the organic matter which was in solution in the water at the top has already diminished or entirely disappeared, being represented, perhaps, by nitrogen, which has formed harmless combinations with oxygen.

It really seems as if the more of the living, growing bacteria you had in the upper layers of your filter bed, the freer became the water below both in bacteria and organic matter. This is, in fact, the case. We do in this experiment what nature does on a larger scale—make the bacteria fight the organic matter and themselves.

But how is this effect produced? The bacteria are so small that hundreds of them could easily pass abreast through the smallest spaces between the sand particles. What holds them back?

When the sand particles at the upper portion of these filter beds have been carefully examined it has been found that they are, after a few days, completely encased in a slimy gelatine-like envelope, formed of a material which many bacteria secrete around themselves as they grow. This bacteria-formed slime more or less fills the pores of the filter bed, enclosing the bacteria themselves and the sand particles, and catches and holds fast on its sticky surfaces not only suspended matter of various kinds but the new bacteria which come onto the filter and start to work their way down through its pores. Here, many of them, like good prisoners, set to work to make the best of the situation, and if their nature permits, turn to and help to make more of this trap-slime to capture the next comers.

Many of the enlarged germs, however, do not form this material and these may die in large numbers where they lie. On the other hand, this enforced detention is simply paradise for many of the germs. Here they are resting at ease in a slimy confinement, with boundless supplies of just the food they want slowly trickling by them. The food is dead organic matter, which the average bacterium simply dotes on and recks little whether it be in solid form or in solution, so there be enough of it. At it he goes then, and by some wholly inscrutable phase of the life power in his tiny body, asunder fall the atoms which have once been parts of animal or plant. That part which the tiny life spark needs to keep its glow agoing is appropriated. The rest he leaves, its atomic cravings unsatisfied, and only too ready to succumb to the wiles of the ever amorous oxygen, which must always be present in a perfectly acting filter bed.

The slowness and the intermittent character of natural soil filtration is a very important matter in the accomplishment of perfect results, because in the times between rains the soil pores have a chance to become filled with stores of oxygen in the form of ground air.

Behold now the secret of this marvelous alembic into which may go things most foul and harmful, but out of which comes the very type of cleanliness—clear spring water. It is largely the bacteria, living, growing, multiplying, following their life impulses silently and unseen, each after its kind, which, supported by the active agency of the oxygen, bring about this beneficent result.—*Prudden, in Drinking Water and Ice Supplies.*

A test made in one of the experimental filtration tanks of the Massachusetts State Board of Health to determine the distribution of bacteria at different depths gave the following results:

Number of bacteria found in one gramme of sand at various depths.

Distance from Surface.	May 22, 1889.	Distance from Surface.	May 22, 1889.
0 to ½ inch	1,760,000	5 inches	63,400
½ to ¾ "	105,000	8 "	30,700
1¼ to 1½ "	207,200	12 "	34,100
2 inches	60,200	19 "	12,300
3 "	111,300	60 "	4,100

The most rapid decrease is in the upper few inches.

Koch says that the micro organisms in the soils he has examined diminish rapidly with the depth and at the depth of a metre the soil is nearly free from bacteria.

The experiments of Lawes and Gilbert indicate that the action of these organisms is very uncertain below a depth of 12 or 15 inches.

When abandoned privy vaults or other deposits of organic matter are laid bare by excavating it will be observed that in the upper portion, immediately beneath the surface, the organic matter has disappeared and that as the depth increases the purification has been less and less until at the depth of several feet it will be found that it has proceeded but slightly even after several years. In fact, abandoned privy vaults are often found in streets which have been used as public thorough-

fares for more than a generation, the lower portions of which show no sensible purification of the organic matter.

It is therefore apparent that there is a radical difference between the processes which ensue in the ordinary cess pool or privy vault and those which follow upon the application of sewage to land under proper direction and by the methods dictated by recent knowledge.

Many interesting facts have been brought out by the experiments of the Massachusetts state board of health during the last two or three years. They can scarcely be touched upon in the limits of a paper of this kind, but I present the following table as summarizing some of the results obtained by various soils for periods of three to eight months, mostly in the second year of filtration.

Character of Soil.	Gallons of sewage per acre per day.	Percentage the sum of ammonias of effluent was of the sum of ammonias of the sewage.	Percentage the number of bacteria in the effluent was of the number in the sewage.
Coarse mortar sand	117,000	1.4	3.
" " "	60,000	0.4	0.02
" " "	55,400	2.5	0.19
Coarse and fine sand and fine gravel	42,600	0.5	0.08
Fine white sand	28,700	0.4	0.003
River silt, mostly fine sand	13,400	0.6	0.002
Three feet eight inches sand and gravel Ten inches yellow sandy loam Six inches brown soil	8,880	0.4	0.001

The several amounts per acre of sewage set opposite the different soils are the amounts they were found by experiment to be capable of purifying indefinitely.

The table exhibits in a general way the superiority of the more open soils as to purifying large quantities of sewage and of the compact and more finely divided soils in removing living organisms.

In the experiments above recorded sewage was applied

intermittently. In intermittent filtration the nitrification was active and, as shown by the ammonias, 99 per cent of the organic impurities were removed, while in continuous filtration the nitrification ceased, and the same sand filtering the same quantity of sewage, stored impurities for a time, but finally poured out an effluent quite as impure as the applied sewage.

This shows distinctly the radical difference in result between intermittent and continuous filtration, due undoubtedly to a lack of oxygen.

It is proven that these processes of purification may proceed in this latitude in winter. The experiments at Lawrence, Massachusetts, have shown that the nitrification was about nine-tenths as complete in winter as the mean for the year.

It should be stated in this connection that nitrates which are the product of the nitrification or oxidation of the organic matter contained in sewage, supply nitrogen in its most available form as plant food. In the absence of plant life the excess of these nitrates, being very soluble, passes away with the effluent in a harmless form making the soil self-renewing in its capacity for sewage purification. Instances are on record where sewage has been applied to the same area for more than a century and the soil still effectively purifies it.

The following practical conclusions may be drawn from the facts above cited:

1. The sewage should be applied at or near the surface of the ground in order that the bacterial action may be complete.

2. The soil should be thoroughly aerated so that the oxidation may be as thorough and rapid as possible.

The second of these considerations demands that the soil in order to purify considerable quantities of sewage shall be porous and reasonably free from finely divided particles having a tendency to form, with the sewage, a surface coating which may exclude the air; and also that the sewage be applied intermittently so that the air, following the lowering stratum of sewage, may be drawn into the pores of the soil and intermingled with the sewage.

Sewage may be applied by the following methods:

1. Broad irrigation.

2. Intermittent filtration over limited areas.

3. Sub surface irrigation at the depth of a few inches below the surface.

Broad irrigation is available when large areas of land can be obtained somewhat removed from compactly built neighborhoods and where the utilization of the sewage is desired.

The amount of land necessary for this method of disposal varies according to circumstances but for ordinary conditions may be said to be about one acre for each 100 persons.

Intermittent filtration is available where the amount of land that can reasonably be secured is limited. On properly prepared areas of porous soil one acre of ground will be sufficient to purify about 100,000 gallons of sewage daily, indefinitely, or for about 1,000 persons at the usual rate of sewage per capita in the United States.

Sub surface irrigation is applicable to isolated houses, public institutions and to small villages where a suitable soil can be obtained. It has advantages over any of the other methods in that it can be employed nicely on a small scale to meet the wants of a household of a few members, or on a larger scale to meet the wants of a larger number, without complications arising from a necessary association of interests. It requires less attention than the other methods and there is nothing unsightly about it.

In the current number of the Engineering Magazine (January, 1892) Geo. W. Rafter, C. E., in an article on "Sewage Disposal" gives the following résumé of the question of sewage disposal as it stands today:

1. By reason of the lack of cheap labor, broad irrigation will not, generally speaking, be adopted in this country.

2. Intermittent filtration is the preferable method where a high degree of purity is required and the conditions admit of its use.

3. Chemical treatment may be used where the object is to merely purify the sewage enough to admit its discharge into a stream or other body of water without creating a nuisance.

4. Chemical treatment alone should never be used where the effluent goes into a stream, pond or lake used as a public water supply at any point within the influence of the sewage.

5. Combination treatment by chemicals and intermittent

filtration may be used when a high degree of purity of effluent is required, but at greater cost usually than by intermittent filtration alone.

To decide just which method to use in any given case will require the best judgment of a skillful sanitary specialist.

Mr. Rafter also remarks that within the next few years we may expect to see a great extension of sewage disposal works in all parts of the country.

In March, 1891, the writer made an examination of the sewage filtration beds at Pullman. The soil of the filter beds is the rich alluvial prairie soil underlaid by a yellowish clay subsoil and poorly adapted for purifying large quantities of sewage, especially when the temperature is low. Nevertheless, the results obtained here are very flattering.

A sample of the crude sewage was taken at the end of the carrier for analysis, and also a sample of the purified effluent was taken from the man-hole to which the tile drains converge. The effluent was clear and sparkling and not unpleasant to the taste. The table below contains the results of an analysis of the samples collected as above stated.

Analysis of crude and purified sewage from the Pullman sewage farm (Parts per 100,000.)

	Crude sewage.	Purified sewage.
Temperature	51° F	38° F.
Albuminoid ammonia	.60	.040
Free ammonia	.30	.037
Nitrogen as nitrates	.41	.180
Oxygen required to oxidize organic matter	6.40	.760
Chlorine	4.20	2.100

The degree to which the purification has proceeded (assuming that there has been no concentration or dilution of sewage from evaporation, subsoil water or other causes) is indicated by the following table:

Albuminoid ammonia	.93½ per cent.
Free ammonia	.88 " "
Nitrates	.56 " "
Oxidizable organic matter	.88 " "
Chlorine	.50 " "
Total nitrogen in the effluent	.21½ " "

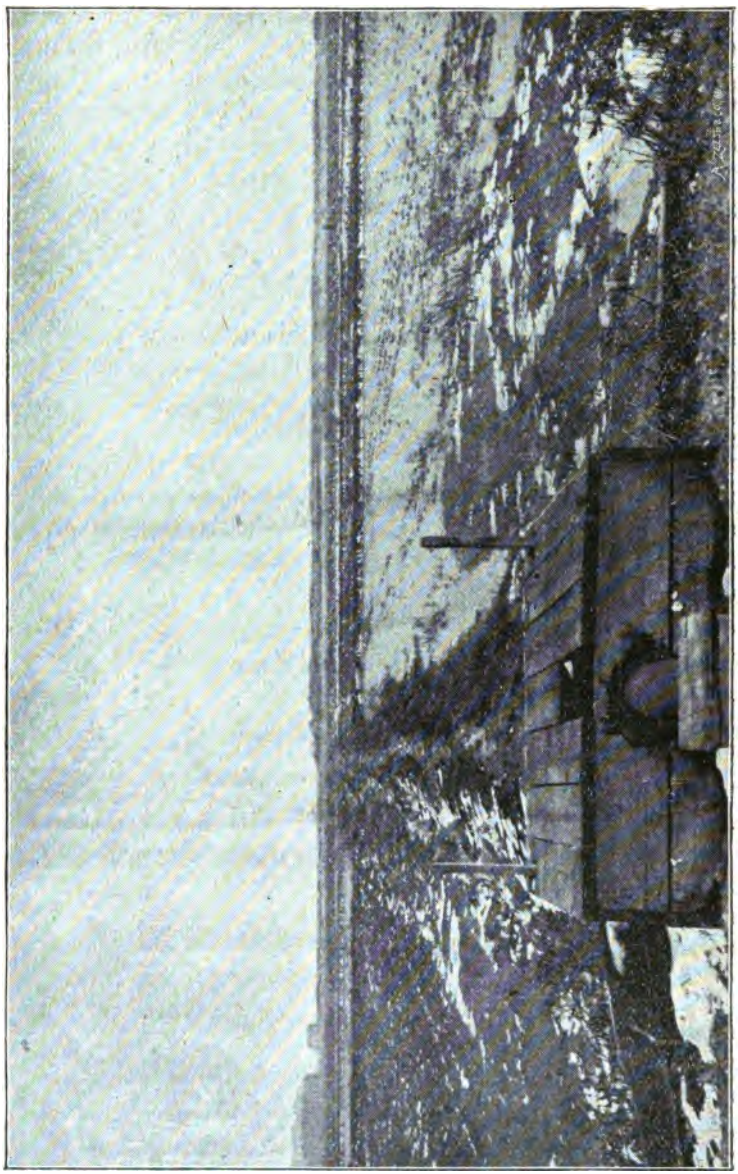

Fig. 1.

Much more favorable results may be expected, of course, during the warmer weather. The intention was to ascertain the conditions at about the most unfavorable season.

Fig. 1 is reproduced from a photograph of the filter beds taken at the time.

The method of sewage disposal by sub surface irrigation (which is but a form of intermittent filtration) is applicable in so many instances that a more detailed statement of the process may be of interest.

The object sought is the intermittent distribution of the sewage immediately beneath the surface, preferably of lawns or other grassed areas. The purification at this point being as previously stated, most rapid and giving no offense to the senses. The requisite appliances are the following: A water tight tank or chamber to receive the sewage and from which it may be discharged at intervals and a network of agricultural tiles laid beneath the surface with open joints through which the sewage may exude.

Practice indicates that as the sewage comes from the house it should first pass into a small catch basin or chamber adapted to intercept the solid matters and grease from sinks, etc., passing from this into the tank proper from which it is discharged either by hand or automatically. The general arrangement of the system is shown in Fig. 2. From the collecting tank the sewage passes through a pipe with impervious joints to the irrigation field which may, if the conditions are favorable, be within 25 or 50 feet for single houses. The distributing pipes are of small diameter and should be laid about eight or ten inches deep. They should have a slight fall which is secured by laying them on lines closely conforming with the contours.

Special appliances are now manufactured for use in this system which serve to perfect the details, but the system may be constructed from materials which can be bought in almost any town.

The system as above described contemplates the disposal of solid matters from water closets and other matter usually discharged into sewers. Where applied to the disposal of liquid waste only as in connection with a system of earth closets it may be somewhat simplified.

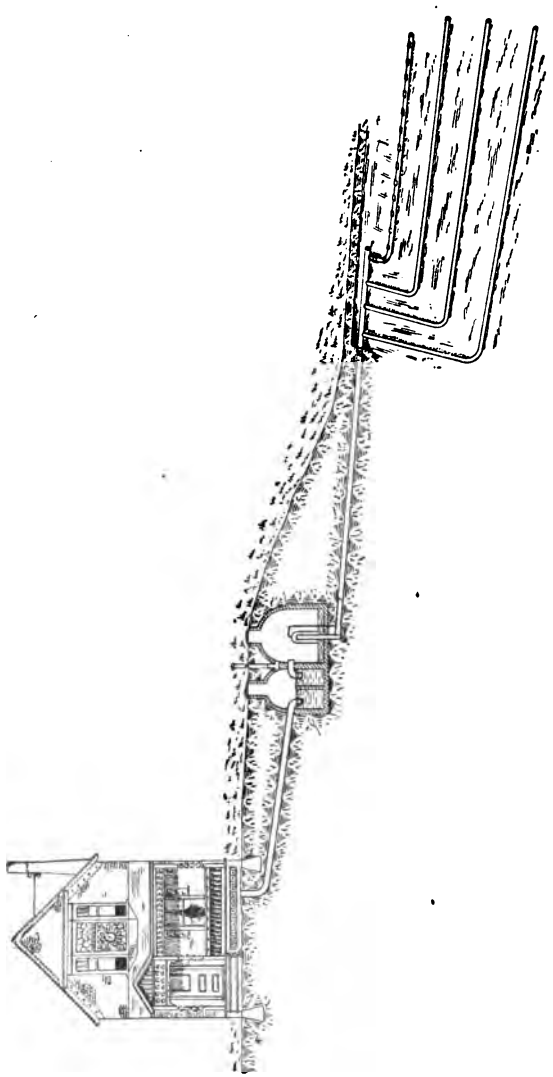

Fig. 2.

Fig. 2 shows the collecting tank fitted up with an automatic syphon by which the sewage is discharged at proper intervals without attention, a very desirable feature. The ordinary round agricultural tiles laid in special gutter pieces and covered at the joints with special caps to exclude the earth are generally used. The Y branches are designed to permit the escape of sewage completely from the main lines. A very good substitute may be made from common material as shown in

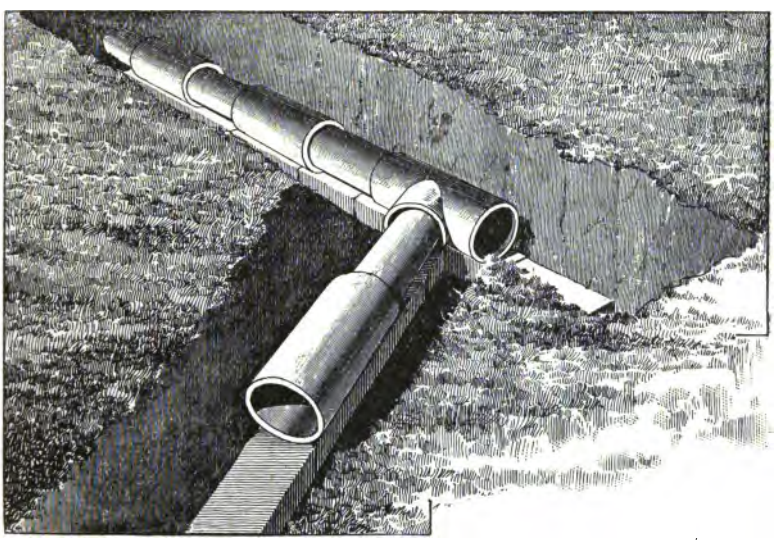

Fig. 3.

Fig. 3. Take ordinary hard burned bricks and lay end to end on the proper grade and at the proper depth. On these lay, as shown in the photograph, alternately, tiles of different diameter, inserting the ends of the smaller tiles in the ends of the larger. The larger tiles will thus serve the purpose of both the gutter and cover plates and the sewage will escape through the space represented by the difference in diameter of the pipes. If after some years it becomes necessary to take up the tiles and clean them the brick foundation need not be disturbed and the tiles can be replaced in their former position with little trouble.

Although it is usual when water closet wastes are admitted

to provide for the interception of the particles having a tendency to clog the distribution drains there will be but a slight accumulation in the intercepting chamber. The solid matter will by decomposition become so thoroughly macerated and dissolved that it will pass off in solution or in the form of small particles in suspension with the liquid. The comparatively small size of the intercepting chamber as compared with the quantity of sewage passing through it daily will prevent its contents from becoming offensive, especially as the chamber is set below the ground. In the case of a single cottage where earth closets are used the intercepting chamber and collecting chamber are sometimes dispensed with, which materially reduces the cost of the system.

Compact soils should be thoroughly under-drained to make them suitable for subsurface disposal. In the case of sandy or gravelly soils it is not necessary.

It is a significant fact that in the case of porous subsoils overlaid by loamy soils which are less pervious, a greater quantity of sewage may be purified by this method than by application to the surface over the entire area. In an experiment detailed in the report of the Massachusetts board of health before referred to, it was found that three times the quantity could be applied by this method with equal results.

The length of tile drains necessary to dispose of the sewage by this method varies from 50 to 200 feet for each person and in open, sandy soils, where the sewage from a large number of persons is contributed it may be less. This is on the basis of 50 to 100 gallons of sewage for each person daily. Ordinary residences properly fitted with modern plumbing and fixtures so that there is no extravagant waste of water will be amply served by 25 to 50 gallons.

The distributing tiles may be laid in lines about four or five feet apart so that the area necessary to serve as the irrigation field will be 250 to 500 square feet for each person. It is apparent therefore, that the ordinary urban lot of 4x8 rods with the area of lawn usually found in the smaller cities of this state will be sufficient for the purification of the sewage of the occupants. And that the area usually found convenient to

most summer resorts in this state which is available for such uses will suffice.

In practice it has been found that the sewage of from 250 to 500 persons can be applied to an acre of ground by this method continuously throughout the year and probably with the unusually favorable conditions to be found in the case of the northern summer resorts of this state where the season is of but a few months duration and the soil generally porous, this amount may be largely exceeded.

As an illustration of the application of this system let us assume the case of a northern Michigan summer resort. The resort will be open to guests from May to October at farthest. By reason of the fact that the soil will have long intervals of rest and also for the reason that at the season when sewage is applied to it the purifying agencies are most active, we may, with reason, considerably reduce the area of the absorption field below the standard which has been established for continuous use.

From results that have been obtained by this method it seems fair to assume that under the favorable conditions assumed one acre of ground will suffice for 1,000 persons and that if the sewage of even 1,500 persons be applied to an acre for limited periods at the height of the season it will still suffice.*

Assuming now a resort accommodating 200 guests there will be required about

2,000 feet of sub-surface drains @ 10c	$200 00
200 feet of carrier @ 25c	50 00
Intercepting chamber	25 00
Collecting chamber	100 00
Automatic appliances	30 00
Miscellaneous	95 00
Total	$500 00

It is doubtful if a resort not within reach of a system of public sewers can be better served than by such a system. It would undoubtedly be the part of wisdom for many resorts sit-

*Col. Waring states that the sewage of Lenox, Massachusetts, having a population of 800 to 1,200, is disposed of by this process on less than one and one-half acres of land throughout the year.

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uated on water fronts and discharging the sewage along them to the offense of patrons, to adopt this method.

Those unfamiliar with this method are inclined to discredit the fact that sewage may be applied in this manner successfully in winter. It is an established fact, however, that where frost penetrates between the drains to the depth of several feet the sewage exuding from the drains keeps the soil adjacent to them open.

The sub surface system of disposal was first introduced by Rev. Henry Moule, the inventor of the earth closet, in 1868, to supplement the earth closet by the removal of the liquid matter. The growing popularity of the water carriage system of removal has influenced its development until at the present time it is held by leading sanitarians as offering the best solution of the problem of isolated sewage disposal.

PRESIDENT: Gentlemen, the paper is before you for your consideration. I would only remark that our friend, Mr. Pierson, exhibits a great deal of modesty in so quietly and unpretentiously making other people say those things he knows so well himself, and giving them the credit of knowing them, without taking any himself.

Remarks are in order from members. There are gentlemen here who have had experience in this matter. Would be glad to hear from them.

COL. MUENSCHER: I would like to ask Mr. Pierson if the result of his recent experiments was that in attempting to purify sewage by filtration, the larger surface exposed the better, that almost all purification is within the first few inches of the filter?

MR. PIERSON: That directly and logically follows. The number of bacteria decreases very rapidly below the first few inches.

COL. MUENSCHER: So, as long as you get a large surface, it is no great object to get a large depth. I have been a little surprised at the different results I have seen. How do you count these organisms? Do you use the microscope for making an estimate?

MR. PIERSON: Yes, I can find them, but I cannot count

them directly. It is done by distributing small quantities of sewage over surfaces adapted to the growth of bacteria. The number of colonies of bacteria which appear is a basis from which the number of bacteria in a given volume of the sewage may be computed.

COL. MUENSCHER: Do you find these organisms to be mostly animal or vegetable?

MR. PIERSON: Mainly vegetable.

COL. MUENSCHER: Don't destroy each other, do they, one vegetable destroy another?

MR. PIERSON: Well, they destroy organic matter; yes, they destroy each other. They dispose of organic matter.

MR. HODGMAN: The big fish eat the little ones.

OWNERSHIP OF LAKE BEDS.

F. HODGMAN.

Since my paper on this subject was read before this society, the Supreme Court of the United States has passed upon the question with reference to the ownership of a lake bed in Illinois in which they lay down the following principles:

1. That patents, by the United States, of lands bounded by streams or other waters, in the absence of reservation or restriction of terms, are to be construed as to their effect according to the law of the state in which the land lies.

2. In Illinois, the common law being in force, a patentee from the United States of land there situated, bounded by the water of a small lake, takes to the center of the lake.

3. Meander lines, as shown by the United States surveys, do not constitute the boundary. The water is the real boundary.

4. When a patent is issued for land bounded by a lake or stream, the title to the land under water passes from the government, and subsequent action of the land department in surveying and granting the latter land is without authority and void.

Hardin vs. Jordan, 2 Sup. Ct. Rep., 808.

The reasons of the court in coming to these conclusions are given at too great length for the columns of the Annual. The controversy was in regard to the ownership of the bed of Wolf lake, near Chicago. One party claimed a portion of it under the common law, claiming title through a government patent of adjoining fractional lots, and the other party claimed title from a subsequent survey of the uncovered lake bed and purchase from the government. In closing the case the court says: "On the whole our conclusion is that the court below should have given judgment for the plaintiff as against the defendant, to the center of Wolf lake, instead of to low water mark in front of 'certain lots' and to the middle of the bay or projection of the lake in front of 'a certain other lot.' If there should arise any question between the plaintiff and other riparian owners of lands situated on the margin of the lake as to the convergence of the side lines of the plaintiff's land in the lake, it can be disposed of by the parties themselves by a resort to such form of procedure as may be proper."

Three of the judges dissented from this, and as their opinion is comparatively brief and covers the points at issue it is reproduced in full from the Supreme Court Reporter for June, 1891:

HARDIN v. JORDAN.

(May 11, 1891.)

BOUNDARIES—PUBLIC LANDS—SMALL LAKES.

Under the laws of Illinois, a patentee from the United States of land there situated, bounded by the waters of a small lake, takes only to the water's edge. Per Brewer, J., dissenting. Gray and Brown, JJ., concurring.

BREWER, J. (*dissenting*). Mr. Justice Gray, Mr. Justice Brown and myself are unable to concur in the foregoing conclusions. Beyond all dispute, the settled law of this court, established by repeated decisions, is that the question how far the title of a riparian owner extends is one of local law. For a determination of that question the statutes of the state and the decisions of its highest court furnish the best and the final authority. In the case of St. Louis v. Rutz (decided at the

present term), 138 U. S. 226, 242, ante, 337, 343, it was said by Mr. Justice Blatchford, speaking for the court: "The question as to whether the fee of the plaintiff, as a riparian proprietor on the Mississippi river, extends to the middle thread of the stream, or only to the water's edge, is a question in regard to a rule of property which is governed by the local law of Illinois. Barney v. Keokuk, 94 U. S. 324, 338; St. Louis v. Myers, 113 U. S. 566, 5 Sup. Ct. Rep. 640; Packer v. Bird, 137 U. S. 661, ante, 210. In Barney v. Keokuk it is said that, if the states 'choose to resign to the riparian proprietor rights which properly belong to them in their sovereign capacity, it is not for others to raise objections.'" The cases referred to in this quotation affirm the same doctrine. If we turn to the decisions of the supreme court of Illinois, we find one rule laid down for running water and another for lakes and ponds. In the former case the riparian owner owns to the thread of the current; in the latter to the water line. No distinction is made on account of the size of either stream or pond. Without noticing the authorities in reference to rivers or other running water, it is enough to refer to the decisions in reference to lakes and ponds. In the case of Seaman v. Smith (decided in 1860), 24 Ill. 521, 525, it was held that a riparian owner on a large lake (Lake Michigan) took title only to the water line. The reason of that decision was thus expressed in the opinion of the court: "These great bodies of water, having no currents, like rivers and other running streams, cannot present the same reasons why the boundary should be extended beyond the water's edge, where it is ordinarially found, that apply to running bodies of water. Where such streams are called for as a boundary, the thread of the current is held to be the line from each side. Such a rule could not, for the want of a current, be adopted in this case. It would not be sanctioned either by analogy to the rule or by reason. And if the outer edge of the water be passed, owing to the approximation of these bodies to a circular shape, it would be found exceedingly difficult, if not impossible, to ascertain where the boundary should be fixed, or the shape it should assume." It will be perceived that the same reasoning applies whether the lake be a large or a small one. There is no decision or intimation by the supreme court of that state

questioning the rule thus laid down. Again, in 1886, in a later case (Trustees v. Schroll, 120 Ill. 509, 12 N. E. Rep. 243), the question arose as to a small lake, no larger than the one in controversy, and the same rule was applied there as in the case of Lake Michigan; and it was held that the title of the riparian owner stopped at the water line; and the case of Seaman v. Smith, supra, was cited as furnishing the authority and reasoning for the rule. Nor was this a mere casual or incidental remark in the course of an opinion. The opinion is some seven pages in length, and over four pages are devoted to a discussion and decision of this question. It was the principal and paramount question, fully reasoned out and obviously carefully considered. We quote as follows: "It is equally well settled that grants of land bounded by streams or rivers above tide-water carry the exclusive right and title of the grantee to the center of the stream, *usque ad filum aquæ*, subject to the easement of navigation in streams navigable in fact, unless the terms of the grant clearly denote the intention to stop at the edge or margin of the stream. 3 Kent Comm. 427; 2 Hil. Real Prop. 92; Ang. Water-Courses, § 5; Jones v. Soulard, 24 How. 41; State v. Milk, 11 Fed. Rep. 389; Canal Appraisers v. People, 17 Wend. 596; Child v. Starr, 4 Hill, 369; Seaman v. Smith, 24 Ill. 521: Rockwell v. Baldwin, 53 Ill. 19; Braxon v. Bressler, 64 Ill. 488; Ice Co. v. Shortall, 101 Ill. 46. But an entirely different rule applies when land is conveyed bounded along or upon a natural lake or pond. In such case the grant extends only to the water's edge. Angell, Water-Courses, §§ 41, 42; 3 Kent, Comm. 420, note *a*, citing Bradley v. Rice, 13 Me. 201, and Waterman v. Johnson, 13 Pick. 261. See also, Warren v. Chambers, 25 Ark. 120; State v. Milk, (U. S. Cir. Ct. Dist. Ind., Gresham, J.,) 11 Fed. Rep. 389; citing Wheeler v. Spinola, 54 N. Y. 377; Mansur v. Blake, 62 Me. 38; State v. Gilmanton, 9 N. H. 461; Paine v. Woods, 108 Mass. 160; Fletcher v. Phelps, 28 Vt. 257; Austin v. Railroad Co., 45 Vt. 215; Boorman v. Sunnuchs, 42 Wis. 233; Delaplaine v. Railway Co., Id. 214; and Seaman v. Smith, 24 Ill. 521. See also Nelson v. Butterfield, 21 Me, 229; West Roxbury v. Stoddard, 7 Allen, 158; Canal Appraisers v. People, 5 Wend. 423; Jakeway v. Barrett, 38 Vt. 316; Primm v. Walker, 38 Mo. 99; Wood

v. Kelley, 30 Me. 47." And again: "Indeed, the controlling distinction between a stream and a pond or lake is that in the one case the water has a natural motion—a current—while in the other the water is, in its natural state, substantially at rest. And this is so, independent of the size of the one or the other. The flowing rivulet of but a few inches in width is a stream as certainly as the Mississippi. And when lands are granted by the proprietor of both land and stream, bounding such grant upon the stream, the grantee acquires right and title to the thread or middle of the stream. This right is grounded upon the presumption that the grantor, by making the stream the boundary, intended his grantee to take to the middle of the stream; and this presumption will prevail until a contrary intent is made to appear. Rockwell v. Baldwin, 53 Ill. 19. The right spoken of does not rest upon the principle that when a grant is bounded on a stream the bed of the stream to the thread or middle passes as incident or appurtenant to the bordering land, for the bed of the stream is land, though covered with water, and land cannot pass as appurtenant to land. As is said in Child v. Starr, 4 Hill, 369; 'A conveyance of one acre of land can never be made, by any legal construction, to carry another acre by way of incident or appurtenance to the first.' The riparian proprietor, claiming to the thread or middle of the stream, must show the bordering water to be a stream, and that his grant, in terms or legal effect, is bounded upon or along such stream—that the stream is made the boundary." These quotations show that there was no mere inadvertent or casual remark, but that it was the distinct and well considered as it was also the unanimous decision, of the highest court of the state. We do not think it sufficient to overthrow the force of this decision to say that the common law of England was different—a proposition which, in passing, we may say we doubt; nor that there was another question in the case also referred to in the opinion, which fully justified the decision, and that, therefore, the discussion and decision of this question were unnecessary; for that other question was put after this in the opinion, and was evidently intentionally made subordinate to this. Believing that the law of Illinois has been determined by its supreme court, we think that determination

is conclusive on this court. As strengthening the views we have expressed, may also be noticed the opinions of the circuit and district judges in this very case, on separate trials (see 16 Fed. Rep. 823), both announced before the decision in 120 Ill. and 12 N. E. Rep., and agreeing that, under the laws of Illinois, the title of the riparian owner stopped with the water. The long judicial experience of those judges, and their familiarity with the laws of Illinois, give to these opinions great weight. We therefore dissent from the conclusions of the court.

ENGINEERING FOR CEMETERIES.

O. C. SIMONDS.

[Supt. of Graceland Cemetery, Chicago, Ill.

I was very much surprised yesterday when Mr. Skeels called upon me to say something to the engineers, and so made no special preparation, and I will talk to you in a haphazard way about engineering in cemetery matters. That is what Mr. Skeels asked me to speak of, and if I fail to touch upon any point of interest, I will be very glad if you will interrupt me with any questions.

In the first place, the land selected for cemetery purposes should, for manifest reasons, be of a porous nature, and have a good natural drainage. After the land is selected the first thing in order is to locate the drive ways. These should be located so as to make it as convenient as possible for a person to reach any given point from the entrance of the cemetery, and that would make it necessary that the drive ways, starting from the entrance, should branch out in easy curves, following the lay of the land to some extent, and dividing the whole area into sections, elliptical in shape and having the shorter axis in every 100 feet. We have been taught how to lay out curves of various kinds, circular, parabolic and other geometrical curves, but when a person comes to lay out curves in a park, he ought not to attempt to show his skill in laying out geometrical curves. A curve laid out by the eye is always more pleasing

than one based on geometrical principles. Of course the topography will influence the drive ways, so a map is necessary. The best instruments to use in obtaining such a map are the transit and stadia—the method with the stadia being more correct than where it is divided into rectangles.

After locating in a general way the drives, the method usually employed now to exactly locate the drive way, is to take a bundle of sticks, putting them about where you would like to have the drive. I usually put the sticks on one side and stand away, having a man to move the sticks until I get a drive way satisfactory to my eye. After you get one line it is a simple matter to measure across and locate the other line. The width of drives is usually from twenty to thirty feet. Twenty feet is rather narrow, because people are always attempting to turn, and that scarcely gives room to turn, without encroaching on the sides. Thirty feet I consider ample.

In regard to grades. Gilmore recommends a longitudinal grade of not less than one foot in 125, and not more than six feet in 100. If possible, get some fall or rise to a street so that the water will run lengthwise, and you will always find that you can keep your streets drier, than if you have the center line perfectly level, and it is more pleasing to the eye. Avoid all useless curves. Never put in a circle so a person feels he is going out of his way.

After the drive ways are located and the grades are established, it will be necessary to grade the land on either side no doubt. You should try to avoid grading as far as possible, because if you use the natural surface you have the natural soil, and if you disturb it you never can get quite so good soil as you have to begin with.

Frequently we use too much engineering in cemeteries. If we look along a drive, we see something that looks like a railroad embankment. We should always try to imitate nature, and get natural curves. Mr. Strauss, the leading landscape gardener in his day, said one time that the surface of the drive should be tangent to the roadway. For instance, if the section adjoining the road is higher than the roadway, the immediate surface along the drive should be concave. Start out level and gradually rise up. If the ground is lower than the street, of

course the surface should be tangent and gradually fall. However the drives should be in the low land if possible. You always measure the height of land with the driveway as a basis. If the land is higher than the drive, "this is high, nice land," but if lower than the drive, you get a low piece of ground. This is of advantage in draining the sections also, and of course the drives will need drainage by means of sewers, and so you take care of all the water in one location.

After the drives and sections are graded, the next thing in order will be planting trees. That is not usually considered a matter of engineering, but nearly all men are called upon at some time to plant trees, and so I will just state a few points that should be taken notice of. You should always avoid planting a tree lower than it stood before being moved. It looks bad to see trees standing in holes, and not only looks bad, but is bad. It is bad in appearance, and if you cover the roots afterwards, it is almost certain to die. A tree needs air. The first thing I would say then in planting a tree, would be not to plant it too low. About Chicago it is very common to plant trees of large size. They are usually dug out with a large mass of earth attached and that is rolled onto a wagon something like a stone truck. The trunk of the tree is bent over and rests on a support by the hind axle. The danger here is that the bark will be injured where it rests on this support, and still trees are moved very successfully in that manner. We have moved some trees of quite large size, nearly three feet in diameter, in a different way.

The trees have been undermined and timbers run through underneath. Then laying timbers under these, and the whole tree has been raised up in its upright position with jack screws, just as you would raise a house, and then the tree has been moved, just as you would move a house, with capstan and chains. Some trees we moved had a spread of sixty feet, and grew with almost as much vigor as though they had not been moved. These trees I speak of now were only moved a short distance. There is danger in moving such a large tree in an upright position, that the wind may blow it over, and so in moving the last large tree I had a hole made right through the tree. Many people seem to think that because if you injure the heart of a

man he will expire immediately, if you injure the heart of a tree it will die, but the life of a tree is in the bark, and many times a tree will live for years and years without any heart at all, and so I anticipate that the hole which we made through the tree, and through which we put an iron bar, will not injure the tree; not nearly so much as taking off the bark where it might rest on the wagon. This tree weighed, with root and dirt, something like forty tons, so we never could have moved it on a wagon.

MR. APPLETON: Will you tell us the variety of these trees.

MR. SIMONDS: All these large trees that have been moved in this way are elms. They have roots spreading out near the surface of the ground.

MR. APPLETON: Did you ever try oak?

MR. SIMONDS: The oak tree cannot be moved in that way if it is a great size. We have moved oak trees perhaps five or six inches in diameter, but we never attempt to move an oak tree of any larger size.

MR. APPLETON: Hickory trees?

MR. SIMONDS: No, you cannot move hickory trees; but you can move maples, lindens, elms, iron-woods.

MR. APPLETON: Usually move those large trees, don't you, in the winter, with the leaves off and frozen boughs?

MR. SIMONDS: All trees should be moved when the leaves are off, but it isn't necessary to have a frozen bough. If I can have the roots well taken care of, and the dirt remain, I would rather move it in warmer weather.

MR. APPLETON: I have had some experience, and in porous soil, you lose the soil too much.

MR. SIMONDS: Yes, in such case, it is better in the winter. But I remember one tree moved in the winter, and during the moving of the tree we had some very cold weather, and the roots were killed all around, about two or three inches. So if you can move trees when there is no frost in the ground, I think it is preferable.

COL. MUENSCHER: Were you trying to get the entire root?

MR. SIMONDS: We get all the roots we can, and then when the tree is planted, the ends of the roots should be cut off.

COL. MUENSCHER: In moving these trees of such large diameters, you put rollers under it?

MR. SIMONDS: Yes, just like a house.

MR. STEELE: I have noticed in this gentleman's remarks that he didn't pay any attention to a geometrical figure on the ground. How is it he would describe his lots? How are they bounded, and what method is used to plat or define them?

ANSWER: I omitted to say anything about the subdivision of a section into lots. The way we have done in making plats and surveys, is to first stake out the drive, and then survey it, and then we stake out lots with the sides at right angles to the line of the roadway, putting large lots near the drives and smaller lots in center sections. In some cemeteries all are the same size, but the wishes of purchasers vary, and you can get better effect in this way, so you keep breadth along either side of your drives. Now these lots are surveyed and platted with the same accuracy that rectangular lots would be.

MR. STEELE: That is the point I wanted to get at How can you, your curves are not regular at all?

MR. SIMONDS: Many of the lots are rectangular, but suppose we had a lot fronting on a curved street, the sides might be straight, but the front curved, and that would be defined by a straight line joining the two corners next to the driveway.

MR. STEELE: You then would describe a curve of a short arc, and find the ordinate?

MR. APPLETON: In regard to the alleys. Of course you put alleys between lots. How broad do you use?

MR. SIMONDS: We have no alleys. We have what we call walks, but you would not detect them. The lawn is continuous and these walks are simply spaces, covered with grass, same as the lots, and they are not followed by people in going over the cemetery. If a man wants to go from one point to another, we have no difficulty in having paths for them over the lawns. These walks serve a purpose. If we wish to carry material, we can follow these walks, and so not trespass on people's lots, but visitors are not expected to follow them, and usually do not.

I mentioned that sections should be elliptical. The walks should generally be transverse. Of course you have some

walks in the other direction, but you should always be able to come out at one side of your ellipse and reach the driveway.

MR. STEELE: And as to the width of these walks?

MR. SIMONDS: We usually make the width three or four feet. When the cemetery of which I am superintendent was first laid out, the walks we made ten feet wide, but it was a great waste of land.

MR. APPLETON: We found that with less than eight feet the wheels of the wagons loaded with marble cut into the lawns, and that is very objectionable.

MR. SIMONDS: Stone men are never allowed to drive in a new section. They simply follow the drives, and then wheel in the marble.

MR. APPLETON: Then you have small sections?

MR. SIMONDS: We have some six or eight hundred feet long; but we don't want to destroy the beauty of the cemetery for the convenience of the stone cutter.

MR. APPLETON: A very expensive twenty ton monument, for instance, requires some mechanical means for getting it there?

MR. SIMONDS: Yes, but that cannot be done with horses and wagons.

MR. : There was one matter connected with Mr. Steele's question: Do you furnish each person a plat with his deed, or is there a plat on the back of his deed, or in what manner do you indicate to the individual the written evidence of the location of his lot?

MR. SIMONDS: We give any one a plat that asks for one. We usually give the purchaser of the lot a plat of the whole cemetery, and the lots are numbered and the description calls for lot such a number in such a section.

MR. : That is customary, and in some cemeteries they use a form, upon the back of which is printed a plat of the cemetery.

THE PRESIDENT: Any more questions you would like to ask Mr. Simonds? If not, the next thing for our—

Motion made and supported to tender the thanks of the Association to Mr. Simonds. A unanimous vote.

REPORT OF COMMITTEE ON QUESTIONS OF PRACTICE AND DISCUSSIONS.

Your committee would respectfully report the following questions submitted to them, and the answers adopted:

No. 1. Should the surveyor endeavor to locate an error in an old plat, which error must otherwise be treated as surplus or shortage?

ANSWER. Yes. In case the plat was made from an actual survey, in which the lots were marked out upon the ground,—an evident error in the plat would be controlled by the survey, and the subsequent surveyor should endeavor to locate the lines just where they were originally laid down. In case the plat was made without a survey, the surveyor should endeavor to lay down the lines so as to comply with the prevailing intention as shown by the plat itself. A line laid down as a straight line in a plat might prevail over an erroneous distance which would make the line a crooked one.

No. 2. Should a ditch for drainage purposes ever be laid in curves instead of straight lines with angles?

ANSWER. Yes. The tangents should always be connected by curves and no sharp angles permitted in the line of the ditch. As a rule, the radius of the curve should be short, because of the inconvenience of working land on a curve.

No. 3. Having the bearing trees to a section corner, one or both standing near the line and at a considerable distance from the corner, how shall I locate the corner?

ANSWER. Circumstances will alter cases. No rigid rule can be given. In a general way, find the meridian, and measure (or length of chain) of the original survey as nearly as can be done under the circumstances; locate the point accordingly, and then dig for the corner stake, availing yourself of every bit of evidence that will throw any light on the location. Mr. H. F. Bean suggests that the location of the line may be determined very closely by calculating the latitudes and departures of the bearing trees from the corner, and running

and measuring off the appropriate distances from the bearing trees. For instance, suppose the corner is located in a marsh and the bearing trees on its margin both standing are described as N. ½° E. 11.90 chains, and S. 1¼° W. 12.60 chains.

A measure of 10¾ links west from one bearing tree, and 27⅓ links east from the other will approximate very closely to the original line, and a pro rata measurement between the points thus located will come very near the corner.

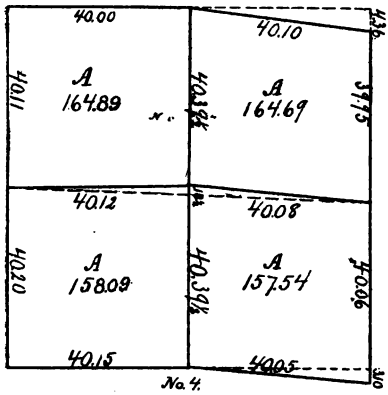
No. 4. See cut No. 4. In running the E. and W. ¼ line straight, the N. ½ of the section will contain about fourteen acres more than the S. ½. Subdividing the N. E. ¼ into halves in the usual way, the west part will contain 2.27 acres more than the east. What is the proper method of subdividing this section to do justice to parties claiming equal portions?

ANSWER. If the conveyances are made in accordance with the system of the United Stated surveys, the lines must be located accordingly. The quarter lines will be straight lines from each quarter post to its opposite corresponding corner, whether the section lines are straight or not. If parties claim equal areas they should show by their chain of title that they have a right to it, in which case the lines should run accordingly.

No. 5. See cut No. 5. In surveying the N. W. ¼ of a section I found the dimensions as in the figure. One deed calls for the W. ½ and the other for the E. ½ of the N. W. ¼. The quarter section purports from the official plat and U. S. field notes to be 160 acres. How should I draw the line between them?

ANSWER. The answer to No. 4 applies also to this. If the conveyances are in accordance with the United States system of surveys the line will be drawn midway between the quarter line and the section line. It may be necessary to trace the title back to determine this question. If not conveyed on the U. S. system then equal areas should be given.

No. 6. See cut. Assuming the quarter post of section 32 to be properly placed, would it not be in accordance with the act of Feb. 11, 1805, to take the half sum or half difference of the distances apart of the section corners for that of the quarter posts? The corners of section 5 are regulated by those of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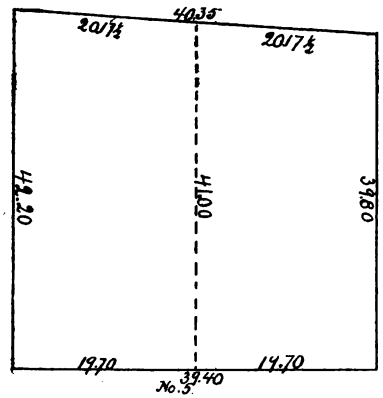
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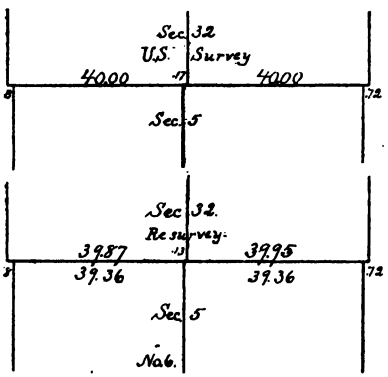
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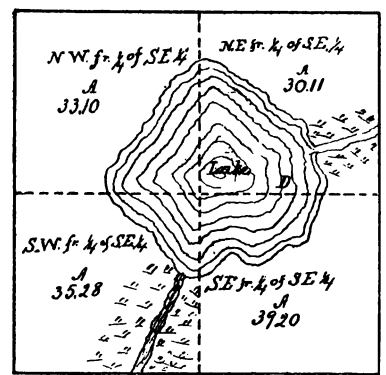
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A
33.10
NE fr. ¼ of SE ¼
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Lot 40
SW fr. ¼ of SE ¼
A
35.28
SE fr. ¼ of SE ¼
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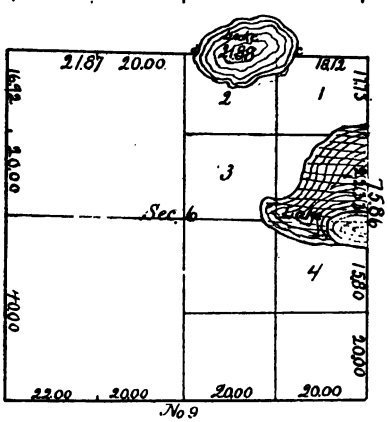
No. 7.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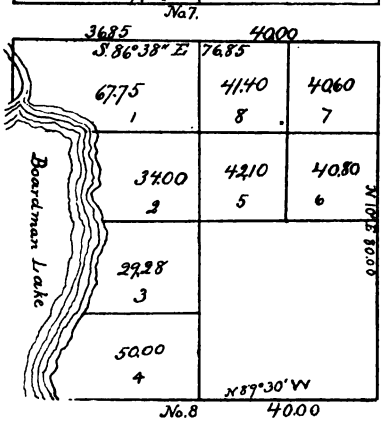
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Boardman Lake
N 87° 30' W
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No. 8

section 32. Why not determine the quarter post in the same manner?

ANSWER. This is open to discussion. The government field notes do not return the distance between the N. E. and the N. W. corners of section five. Under the old system of surveys no quarter post for that section was planted on its north line, and according to law it must be planted midway between the section corners. We do not think that the recorded measure of the south line of section thirty-two should control the measures for locating the north quarter post of section five. The corners of section five are not regulated by those of section thirty-two, except as to line, any more than the corners of thirty-two are regulated by those of five. If the returned distances between these corners do not agree with our measure we cannot move either corner to make them agree.

No. 7. See cut. Four persons own as shown in the cut. The lake has dried away. The last seen of the water was at *D*. Do the owners follow the receding waters till it is gone; or do they stop at the limits of their full descriptions as forties?

ANSWER. The Supreme Court of the United States claims to follow the decisions of the local courts in such cases. The Supreme Court of Michigan decided in Clute vs. Fisher that boundary lines extend along the land under water the same as if there was no water there. The chairman of the committee thinks our court is wrong in this, and that it will ultimately be compelled to lay down a different doctrine and reject this one, for reasons given somewhat fully in the paper on the ownership of lake beds published in last year's Annual.

No. 8. See cut. How shall I run the east and west quarter line of this section eleven?

ANSWER. The instructions of the land department are conflicting in such a case as this. The rule which they lay down, to subdivide in such a way as to suit the calculation of the areas given on the official plat, would seem to be an equitable one in this case.

No. 9. See cut. How shall I subdivide this section six? The figures on the lines represent the government measure. My own measures are:

From S. E. corner north to meander post on south side of lake	40.00	chains.
From same meander post to N. E. corner of section	39.06	"
From N. E. corner west to meander post E. of lake	17.80	"
From same meander post west to quarter post	22.42	"

There is no meander post on north side of lake in the east line. All the other corners are standing all right. The shaded and cross marked part of that lake is upland, and the lake is only 6.00 chains wide on the east line of the section, instead of 22.33 chains, as returned in the field notes.

ANSWER. On the east line of the section the measure between the meander post and the N. E. corner should be prorated; also, the measures on the north line between the meander post and the quarter post. Subdivision should then be made in accordance with the rules for subdividing section six.

F. HODGMAN,
H. A. COLLAR,
GEO. S. PIERSON,
Committee.

DISCUSSION.

MR. HODGMAN: Referring to the question No. 7, perhaps I cannot do better than to quote the following from my last year's paper in giving my reasons for objecting to the decisions of the Michigan and Indiana courts:

"We now come to the question of how the boundary lines shall be extended or located in the lake beds. The answer depends almost entirely on the question of title. If the title of the abutting owners stops at the water's edge, as held in the cases cited, in case the water recedes, the boundary line will be extended according to the laws governing accretions, which are supposed to be familiar to the members of this Society. (See Manual of Land Surveying, Fifth Ed., p. 279.)

"If, on the contrary, the abutting owners own the lake beds also in the manner held in Clute vs. Fisher and Stoner vs. Rice, then the boundary lines are to be located on the same principle as if there was no water there. This view of the case does not seem to me to be sound or just, as a general principle

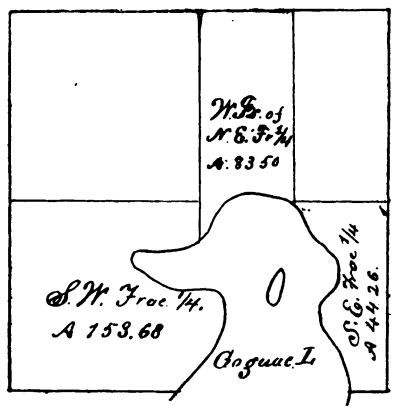
or rule, while at the same time in many cases it would be a very convenient rule, and do no special harm; but,—

"1. The government did not sell the land that way. It has never been conceded by the land department that they sold the land under the waters of meandered lakes. When the lake is not meandered, they sell it, and charge the purchaser the same price per acre that they do for the upland. Would it be just to make one man pay for a lake which is not meandered, and give to another man for nothing the lake that is meandered? It was not so intended.

"2. There are hundreds if not thousands of cases in which this Michigan and Indiana rule cannot be enforced without disturbing vested rights which have been thoroughly settled by the courts. There are fifty or more such cases in my own county alone. The act of 1820 (R. S. 2397) provides that fractional sections shall be subdivided into quarter-quarter sections under such rules as may be prescribed by the Secretary of the Interior. Under that statute, the Secretary of the Interior prescribed rules directing that such sections be divided by north and south or east and west lines, so as to preserve the most compact and convenient forms. It has been definitely settled that these rules were valid and lawful. (See Gazzam vs. Phillips lessee, 20 Howard 372.) Under these rules it has been the custom of the land department ever since to divide these sections so as to preserve compact and convenient forms. In doing so they have frequently attached small outlying fractional lots to an adjoining larger tract, and sold the whole by a description derived from the larger tract. These outlying fractions have not always been in the same section, or even in the same township, as the tract with which and by name of which they were sold.

"Take, for instance, Section 14 in the township of Battle Creek, Mich. The cut gives a correct idea of the official plat of that section, and the manner in which it was sold. Goguac lake lies partly in the section, and has an island lying wholly in the southeast quarter. This island was meandered and sold by itself, and has ever since been occupied by the grantees who derived title from the United States Government. There is a tract of several acres lying west of the lake and east of the

north and south quarter-line which is entirely separated by the lake from the rest of the southeast quarter. It was attached to and sold as a part of the southwest fractional quarter. The north and south quarter-line was not extended across this tract on the official plat of this section. There is another small tract in the southeast quarter, but entirely cut off from the rest of that quarter by the lake. It was attached to and sold as a part of the west fractional half of the northeast quarter. The remaining tract lying east of the lake was sold as the southeast fractional quarter. Now, suppose we attempt to apply this new Michigan-Indiana rule to this case, and see how it works. If as in Stoner vs. Rice, the purchaser of the southeast fractional quarter is entitled to the entire quarter section, he must take away the island from one man, and the tract north of the lake from another, and the tract west of the lake from another, in order to get what belongs to him. But the Supreme Court of the United States (Gazzam vs. Phillip lessee) says that cannot be done, and the Supreme Court of Michigan too (Wilson vs. Hoffman, 38 N. W. Rep. 558), says that cannot be done. Then what becomes of the principle laid down in Stoner vs. Rice? and how are we to determine the boundaries of the island and these outlying fractions on the principles laid down in Clute vs. Fisher? That cannot be done either. The only way such cases can be rightly adjusted, is on the grounds that the owners of the abutting tracts do not own the bed of the lake. But it may be said, This is an exceptional case. Not so; on the contrary, it is a very common case. The township of Ross alone, in Kalamazoo county, has sixteen tracts of land similarly situated.



"Lastly, we may refer to the official plats of the government survey as having some bearing on these questions: 'Lands

are not surveyed lands by the United States until a certified copy of the official plat has been filed in the local land office.' (United States vs. Curtner, 38 Federal Rep. 1.) This official plat defines the location and boundaries of the various tracts into which the section is subdivided. In Gazzam vs. Phillips lessee, the Court tells us the sales to Stone and Etheridge 'were in conformity with the official plat then on file in the local land office.' It determined the extent of their grants. This is the regular course in all government sales of the public lands. Now I find in all the official plats that I have examined, and I assume that it is the same with most if not all of them, that *no part of a meandered lake is included within the marked boundaries of the abutting tract*, and hence is not included in the sales of those tracts. On the official plats, neither township, section, nor any subdivision lines are extended across these lakes. They are entirely segregated from the surrounding tracts."

MR. GREENE: The interpretation of this case seems to me to depend upon the conditions of the grant, like all others. What does the patent say, how is it worded and what is the description? They speak here of the southeast fractional quarter and the west fractional half of the northeast fractional quarter. If this decision just referred to is correct, there is no southeast fractional quarter, it is a full quarter. If this man owns around here, he owns the southeast quarter, and the patent ought to say so, but it does not. It was the intention of the government to grant the fractional quarter. But it is the grant itself that determines the intention of the parties. If you make a deed and describe the land, you are not to go all over the State of Michigan to ask people what they think about it, and a patent is still more in force between parties. It is the government that is parting with its title, on which title all the subsequent purchasers base theirs. So it would seem to me, that consideration alone would show that position to be very weak.

MR. HODGMAN: They practically, by that decision, decide that the word fractional has no meaning whatever as applied to lands bordering on water.

Mr. Steele called attention to question No. 8. [Since the

convention he has sent a copy of the government plat of the section, showing it much more fully than was done by the gentleman who submitted the question. It is from Mr. Steele's plat that the cut is made. He also sent the following statement, which is here given in place of the remarks made in the discussion:]

"In July, 1869, I subdivided this section for Mr. Barlow, who owns lot five and the N. W. $\frac{1}{4}$ of S. E. $\frac{1}{4}$. He is now kicking because the N. W. corner of lot five is not further north so that his house, which is in the street, would not have to be moved. I judge that having acquiesced in this survey so long, he would now be estopped from claiming under a different one. Two years ago, I platted lot one, using my old corner at the S. E. This year I wanted to use the N. E. corner of lot four. This and the center being all torn out, I commenced at the S. E. corner of lot one and twice measured the distance to the south quarter post, giving each lot one-third of the distance. The result in feet was as follows: The S. E. corner of lot one was $1354\frac{3}{10}$ feet from the north quarter post. Each of the other distances was found to be $1351\frac{2}{10}$ feet. The rule of intermediate courses was so nearly preserved that I could not better apply it. You will notice that the area of lots in the N. E. $\frac{1}{4}$ is not reliable. If both E. and N. lines were made 40 chains originally, how could lot eight = 41.40 and lot five = 42.10? or lot six = 40.80 and lot seven = 40.60? I discarded these and took the government distances. By these it is shown that the E. quarter post bisected the E. section line, and that both N. and S. quarter posts were set at exactly 40 chains from the section line."

I depend more on distances given in the field notes than on areas given in the plats. I suppose the areas are derived from the distances, and that hence the distances should govern.

MR. MEIGHAN: The deputy surveyor don't make those calculations in the field. The draughtsman is the man who computes the areas and puts them on the plats, and it seems to me that the correct way would be to take the original distances, and compute from them, and if you can't make them agree let it be as near to the original areas as the proportion will make it.

MR. GREENE: If those distances are not there, I would say

Mr. Hodgman's answer is correct, but having them, I think it should be modified.

MR. HODGMAN: Of course if we could have had the official plat here, it might have modified the answer very materially. But we did not have it, and could only answer in the light of such facts as were given us. In the light of Mr. Steele's statement, the question so far as that section is concerned is no longer an open one. The survey made by him, in 1869, was in exact accordance with one of the rules laid down by the United States land department in regard to the use of intermediate courses, and having been acquiesced in so long, it is now too late to raise a question in regard to it, if it ever could have been done successfully. But suppose it were a new question now, to be settled for the first time. The land department sells such lots as these in accordance with the official plat. The filing of a copy of the official plat in the local land office is an indispensable preliminary to the sale of the land. Legally, the land is not surveyed until this plat is filed. There is this much to be said in favor of the other rule laid down by the United States land department. Each purchaser bought and paid for the quantity of land marked down for his lot on the official plat. The purchasers of lots 5, 6, 7 and 8, bought and paid for 42.10, 40.30, 40.60 and 41.40 acres respectively. Now, if the land be subdivided so as to suit the calculations of the areas of these lots as shown on the official plat, each man will receive his proportionate share of what he bought and paid for. Substantial justice and equity will be done to all of them.

In regard to the statement of Mr. Meighan, that the surveyors in the field did not make the estimates of the areas, that is true now, but it was not always true. There was a time when the surveyors in the field made these estimates. The Surveyor General of the district of Illinois and Missouri, in his instructions to his deputies, printed in 1856, states that "some of the areas seem to have been calculated in one way, and some in another, and some would seem not to have been calculated at all." They were just simply put down by guess, just as some government surveyors in Michigan put down surveys on paper, that they never made on the ground.

PRESIDENT: Gentlemen, what will you do with the ques-

tions that the committee have answered? They are at your disposal for adoption or rejection.

MR. TODD: Mr. President, I would suggest that the last answer would rather contradict the answer to question No. 6, that has been given. The same question is involved. Whether a point, known and marked on a government survey, must be held as in existence, or can be ignored. We have in this case to determine the quarter section corner, which never was set, but we have a point, known as the meander corner, and in setting points between the meander corner and the section corner reference must be had to the meander post, and by the same reasoning the quarter post for section five should be set in reference to the quarter section corner of the adjoining township.

I know that this society has held before, when this matter has come up, that the quarter section corner on the adjoining section has no reference in determining the position of the other quarter section corner; but it is a plain proposition that the thing is equal to the sum of all its parts; therefore, I would beg leave to dissent from the finding of the committee on the question of the quarter section corner. I am of the opinion that it should be located from the quarter corner of section thirty-two, provided that can be identified.

F. HODGMAN: Mr. Todd's remarks illustrate the opening sentence of the answer to that question, that "this is open to discussion." The committee gave their views and still adhere to them.

MR. TODD: I would very much like to hear this matter discussed. It is causing a great deal of trouble where I am from, and there is a great deal of money at stake in the matter, and I wish to be correctly informed as to the proper method of establishing these corners, and it is at the request of a good many land owners of that county, that the society discuss that question, and I think the decision of the society will have great authority in any law suits that may occur.

PRESIDENT: Any other gentlemen wish to speak on this subject?

MR. HODGMAN: The view the committee takes is this: That while it is true, as Mr. Todd says, that the whole is equal to

the sum of all its parts, still to make it true the several parts must be all expressed in terms of the same kind of measure, and not mix up two or more different kinds of measure, aggregate them and call them the sum of all the parts. You might as well say two feet and two links make four feet or four links. Now the surveys and measures of section thirty-two and section five are two distinct and different surveys made, possibly, years apart, by different men, with different tools, and under different circumstances, and while their measurements are all given in chains and links, they are actually different things on the ground. The survey of the south line of section thirty-two is one consistent whole thing of the same survey, the parts of which may properly be aggregated. Not so with the north line of section five. The length of the north line of section five is not returned. There is nothing in the returns to show that it ever was run by the government surveyors. They tell us they ran west on the south line of section thirty-two, but not a word do they say about the north line of section five. When they ran north on the west line of section five they say, "*north between sections five and six*," showing that the measurements and the corner posts on that line were common to both sections. So they did in every case where they were intended to be common for the sections on both sides of the line. Now, if we are to use the quarter post of section thirty-two to locate the quarter post of section five from, we must assume that the jogs given in the field notes were run and measured as a part of the north line of section five, and that the measure is similar to that returned for the south line of section thirty-two. There is nothing in the instructions to Surveyors General, nothing in the field notes as returned, and nothing in the facts on the ground to warrant any such assumption, and not a word in the law which will warrant us in using such an assumption to override the plain words of the statute directing how such corners shall be located. It comes very handy sometimes, and I have located a good many corners that way myself in my earlier practice, but I learned that it led me into grave errors. In 1869 I located the north quarter post in section six in my own township by measuring over from the quarter post of section thirty-one the amount of the jog between

section corners as returned in the field notes. A few years after I found that the jog was not correctly returned in my notes and I had to do my work all over. I was lucky not to be sued for damages. A case occurred in section five of the same town which would have been similar if this case had not forewarned me. Having learned by it that the jogs at the N. W. corner of section five were not correctly returned, I investigated them at the N. E. corner and found a still greater discrepancy. In one case the discrepancy was twenty-eight links, and in the other one hundred and fifty-two links. After that I never mixed up two different kinds of measure in the same line.

MR. SKEELS: I was going to refer to an occurrence of that same kind, where one jog was one hundred and fifty links at one corner, and something at the other. At the one corner where it was reported to be one hundred and fifty links, it was only fifty links. Both corners were standing and the bearing trees were all in place. It has been my practice to measure the mile at the north side of the town, and set the quarter stake in the center of the distance. I think it is the only proper way to do the work.

COL. MUENSCHER: It seems to me that in a case of that sort you should not allow yourself to be governed by any distances which were not intended for that use by the government survey. You should use them only for information. Now, these jogs—those distances don't govern the location of any stake. They are governed by the witness trees, and you are not at liberty, if the witness trees remain, to use these distances to fix the corners, but where the distance is given as fixing the point, then you must be guided by them.

MR. SKEELS: I am something of a crank; but for the information of the young members of this association, would say that we have been plowing a certain part of this field three, four, five, or six times. Members familiar with the former proceedings of the Association and discussions, know this to be so. Now, new members, if they haven't the proceedings of the former conventions, if they will provide themselves with Mr. Hodgman's Manual, will find most of these questions discussed and answered, or so nearly so, that they can from that information proceed to do their work in such a way that even

if the courts follow them right over the ground they will, in nine cases out of ten, find that the work is correct. Now, if you will please accept this in kindness, and look the matter up, you will be very much surprised to see the amount of information in that Manual. Take it in your pocket with you on all work, and it will save a large amount of trouble, and of discussion also.

MR. HODGMAN: I want to thank Mr. Skeels very kindly for his good words for the Manual; but that Manual is a part of the work of this society. Mr. Skeels' remark is true. We are plowing this ground three or four times over, but we have got to keep plowing it if this society goes on. Now, as Mr. Skeels says, we have a good many new members, who have come into this society since these discussions have all been gone over. They haven't the reports and can't get all of them. Some of the most important papers cannot be had now. Others can. But it is just like the children in our schools. One class comes up and takes its degrees, and others take their places, and the teachers have to keep going over the same lessons year after year.

MR. TODD: I don't know but I am misunderstood in some of my remarks, but I believe I am a charter member of this organization, and Mr. Hodgman's report I have the greatest respect for, but I never will accept it as authority on anything in which I think Mr. Hodgman may be in error. I hope to be excused for bringing things before the society on which I may be in ignorance.

MR. HODGMAN: You are right, Mr. Todd. Keep doing it. We have got to keep doing it.

MR. BEAN: This jog business has been discussed a good many times, whether to divide by actual measurement, or proportional distances. The government did not run quarter lines at all. Now, we are told in restoring any measurement, at any point between two posts that were used by the government, that we must use proportional distances, that we must make our measurements conform to theirs. I think if we would do that, it would hit this case.

We will say for comparison that we measure the east forty chains and make it just as the government did. Go to the

west, and come down and find we don't get there into twenty links. Now, where will our point be? In fact, it is a jog of ten links on our own measurement. It is equivalent, I think, to leaving our measurement in conformity with the government measurement. Supposing there were no jogs at either of the corners, should there be a jog at the quarter post?

MR. STEELE: The north line of section five was decidedly bent at the quarter post which belonged to section thirty-two. I was in somewhat of a puzzle to know what to do, because if I ran a straight line between its own section corners, I would have a triangular piece of ground between the lines. I knew at once that could not be done, so I decided to bisect the line, and set the quarter post for five on the broken line, on one side of the quarter post for section thirty-two, and although I have never had a broken line before to establish, I have several times bisected the north line of the fractional section and used a quarter post for line. If I have been wrong in that I would like to be corrected.

PRESIDENT: Gentlemen, I have to discuss these questions in a great many ways. This is the doctrine I have settled down to. Mr. Steele asks if he was right. Yes. In these questions relating to closing corners, I hold this: That when the original corners were set, the township line was then marked and defined. It was there, and it is useless to talk about setting closing corners afterwards, to define or change a line that has already been defined and marked.

So, if you want to find a quarter post on the north or west side of a section where the government surveyors set none, that quarter post must be set equidistant and on the original township line as it was first run and marked.

As far as the jogs are concerned, pay no attention to them whatever, except in finding the location for the corners of the section itself. Then work directly from those corners. This is plowing over old ground, but I have stated the thing accurately and with as few words as possible.

MR. STEELE: The question that Mr. Hodgman answered with regard to the figure on the board was not decided as I understand. Mr. Todd raised an objection to the decision of the committee, and that was pending while you took the chair.

MR. TODD: The question I raised was not this question. It was in regard to locating the quarter section corner. It involved that question. The point I was trying to make was: In their decision in this matter, in refusing to go beyond the meander corner, they were taking opposite ground from their decision in the other, in ignoring the mark placed upon the township boundary, as being a certain distance as given in the government field notes, but in this case they take the meander point and regard that point as immovable.

MR. HODGMAN: I wish to note what I think is a little distinction. In this case the meander post is established by the government survey for that section as a point on the line, and its distance is given from the section corner. In the other case the quarter post was not established for section five and never pretended to be, and nothing is said about how far the post that was planted is from the corner of section five.

MR. STEELE: The question properly before us then is the adoption or amendment of the report of this committee.

SECRETARY: There is no motion.

PRESIDENT: I am prepared to entertain a motion, gentlemen.

MR. SKEELS: I move the acceptance and adoption of the report on inquiries.

PRESIDENT: It is moved and supported, etc. Are there any remarks?

The motion is carried.

OHIO BOUNDARY.

PRESIDENT: We will listen to the report of Mr. Steele on the subject of the Ohio boundary.

MR. STEELE: I think on that subject I am about as nearly blank as on the subject of the World's Fair.

We have had that question of the boundary line of Michigan and Ohio up before the Association before, and I recollect one member took especial interest in it, and gave us some information on the condition of things down there, the sum and substance of which is that people along the line between Michigan and Ohio don't know just where they live. Of course just as quick as we begin to raise that question, we are charged

as surveyors with being interested in a job, that we don't have much to do any way, and we better look up something else. I don't discuss that in any sense in the light of a piece of jobbery, and I don't care who settles it, so that it is eventually settled. It looks to an engineer from a distance that it is a shame if there are people who live in neither the one state nor the other, or to state it a little different, who don't know which state they do live in.

PRESIDENT: Where do they pay taxes?

MR. HODGMAN: In both states, or neither, as the case happens to be.

MR. STEELE: I had supposed that the legislature of last winter paid some attention to the matter, or that a commission was appointed to look into the boundary and prepare for the settlement of the question, but in looking over the proceedings of that body I don't find anything of the kind, so I think it is just where it was, unsettled.

My recommendation is that this Association either appoint a committee independent of myself, or else continue me in the investigation to some future meeting, when I can give them something that is valuable to work upon, which I think could be done by going along the ground or by correspondence with those engineers of ours who are right along the line, who would be pleased to give us all the information needed. We were encouraged to think that the board of supervisors of Hillsdale county would bring it before the legislature, but I am sure that has not been done. I would recommend, therefore, Mr. President, that we have a committee who shall pursue this investigation further.

MR. HODGMAN: I think the matter was laid before the Legislature in 1890 and a resolution passed asking Congress to act on the matter.

MR. SKEELS: I move that Mr. Steele be continued as that committee.

PRESIDENT: Is that motion supported? It is carried. Mr. Steele is continued.

We will listen to the remarks of Mr. Hodgman on the subject of the "Ownership of the Lake Beds," based upon the decision of the Supreme Court of the United States.

MR. HODGMAN: I have but little to add. I have been over the main part of the ground, but I would say that this question was pretty fairly discussed in my paper of last year. Since that paper was written there has been a decision of the Supreme Court of the United States, in which they held that the beds of meandered lakes belonged to the adjacent proprietors in certain cases.

I had intended, if there had been plenty of time, to have read you the decision in full, but that is out of the question now, so I will simply summarize the matter.

The first point that is settled is that the Supreme Court of the United States proposes to follow the lead of the state courts. That is, if the state of Illinois decides that the beds of meandered lakes belong to the adjacent proprietors, all right; if the State of Michigan decides they do not, all right for Michigan, and so on for each state. Each state is a law unto itself. And the question has come up, not only in regard to the ownership, but in regard to the manner of extending boundary lines, whether it should be done according to the common law principles or not. That was one of the questions that came up in the report of the committee on questions.

There is a difference between the common and statute law. Common law comes down from the time when no man's memory runneth to the contrary. It is a growth of usage, and settled by the courts of the different countries, and these decisions have become so permanent that they have been made by the constitution of Michigan a part of the law of the State. The question was raised over in the Dominion whether the laws referred to in my Manual were in force there. "Yes," the crown solicitor replied, "so far as they are applicable to the case."

Under the common law as applied to land bordering on waters, as the water receded the ownership followed it right along, and it didn't follow the direct lines, but went out at some angle in proportion to the shape of the lake.

PRESIDENT: I am in a rather important case at present, and this is the way we propose to present it. Supposing the contour lines to be all drawn, we are going to try to establish the fact that the boundaries of that uncovered lake bed shall be

extended perpendicular to these contour lines. That is practical common law.

MR. HODGMAN: But as Judge Cooley told us, when we are called upon to determine those lines in regard to some of our interior lakes, the surveyor will find himself in the midst of such questions as he never thought of before. But he says, that if the surveyor goes on the ground, and lays down the lines on the ground to the best of his judgment, the chances are, if it comes into court, the court will be governed by his opinion, and it will eventually become the law of the case. Our Supreme Court said that these lands should extend under the water, practically as if there were no water there. I submit to you, that they must beyond question reverse that decision.

PRESIDENT: But the Supreme Court of the United States passed upon this point, the extension of this boundary.

MR. HODGMAN: Yes, they said you must follow the common law doctrine, but they differed. The Supreme Court was divided in this case about as they were in the case of Brown's lessee, vs. Clement. Three judges, Brewer, Gray and Brown, dissented from the opinion of the majority. So, we have two opinions from the court and they don't agree as to what the law in Illinois is, or as to what the common law is. In my judgment the minority are in the right.

If there were time, I haven't a particle of doubt but that the Society would be interested by the reading of these cases in full.

PRESIDENT: Gentlemen, these are matters of great professional interest, and may be matters of great financial interest to us all. In fact, in the case which I referred to in my remarks, I think there are a good many thousands of dollars involved in this very question, and we will endeavor after our very best ability to make some law for you, as definitely as possible, before we get through. We expect to begin in the United States circuit court, and we propose to go on, until we get somewhere.

MR. HODGMAN: Having been called upon to discuss the question of lost corners, I will put what little I have to say on the subject in connection with this discussion. The whole ground has been very thoroughly gone over in my own paper

published in the report of 1881, and Mr. Watkins' paper in the report of 1885. Mr. Watkins' paper leaves little, if anything, more that can be said on the subject. Mr. Kent had a paper on the subject last year, which was not published in the Annual for the reason that we had already published matter covering the whole ground. The substance of it all is to be found in our Manual of Land Surveying, fifth edition, chapter eleven. There is only one rule that can be applied universally without exception to the location of lost corners, and that rule is that the surveyor's whole aim must be to find the point where the corner post of the original survey was actually located, and not where it ought to have been. This is a question of fact to be proved just the same as any other fact, by evidence, and every kind of evidence of whatever name or nature may be used and have its proper and legitimate weight in determining the question. It is unfortunately true that, notwithstanding what has been done by us and by other associations of surveyors, there are still some surveyors left in the country who think they can move the corners of the original survey here and there to suit their own measure, or in case they do not readily find a corner, to plant one of their own where they think it ought to be without regard to where the original corner was located. We all know that such work as that is worse than worthless. The surveyor should exhaust every bit of evidence he can find in regard to the location of a corner before giving it up as finally lost. Look for the bearing trees, for their stumps, for the places where they stood, for the root holes down in the ground, after the trees and stumps have gone. The big roots of an oak or a hickory tree will leave their marks plain in the subsoil for years and years after the trees are gone, and assist in pointing the way to the corner. I have a great deal more faith in old fences as evidence of the location of a section corner or quarter post than I used to have. I have hunted up and restored more than 2,000 government corners, and I find as a rule the fences are good guides to the point where to look for a corner. It is the fences on the half quarter and other interior lines that are more likely to be wrong. Consult the old residents in the vicinity. They may be able to give you valuable pointers. Perhaps they have some private marks to tell them where the

corner is. I have received most valuable aid of this kind. Exhaust all these sources of evidence. Use the pick and spade freely, carefully and intelligently in searching for the corner post. Know what you are looking after, and be sure you know it when you see it. The remains of many a corner stake have been removed and destroyed by persons looking for the corner who did not know the stake when they saw it. When you have found the corner, fix it so it will never get lost again, if it is possible to do so. That is the crowning work of the whole survey. I have no intention of going over the rules for replacing corners which are finally lost. That is sufficiently done elsewhere. What I have already said will give those who need anything of the kind, pointers enough to start them in the right direction in the work.

REPORT OF COMMITTEE ON EXHIBITS.

Mr. L. Beckmann, of Toledo, Ohio, exhibits a five-inch needle, double vernier transit and an eighteen-inch Wye level; also a one hundred-foot Hodgman steel tape.

The transit was on a split leg tripod of good strength and sufficient lightness, in fact the best tripod we have seen. One very small thing is worthy of mention: The opposing nut on the tripod leg bolt is held fast by a set screw. Any surveyor who has had the misfortune to have this nut drop in the last swamp he worked in, will appreciate it.

Your committee consider that the effort to make exceedingly light tripods has been carried too far, especially when a heavy instrument is used with them. A much steadier instrument could be had by reversing the conditions—a *light* transit on a *heavy* tripod.

Mr. B's transit shows fine workmanship in every part, proof enough, we think, that any repairs or designs entrusted to him will be faithfully executed.

The steel tape has an extra foot on the front end. This foot is graduated in tenths, increasing towards the front. This will be found convenient.

The Keuffel & Esser Co., of New York city, exhibit two very fine instruments, a 4½ inch double vernier transit, 10½ inch telescope, and a 20 inch Wye level. The transit exhibited some of their recent improvements, such as bent standards, short telescope axis, hinged shades to verniers, white compass box, and double centers. It was a complete proof that this firm are using their best efforts to improve the transit in every possible way. Your committee observe that the split leg tripod exhibited by this firm is grooved out on the inside to make the legs lighter. This, we think a mistake, as it lacks strength.

The level shown by this firm is of the very best construction. The exhibit made by this firm, your committee consider, is worthy of a more extended mention than we have opportunity of making.

The other exhibits were of such instruments as had been used about the city, such as a Buff & Berger transit and level, a Gurley old style transit, a Heer & Seelig transit, a Stackpole & Bro. transit, and a Heller & Brightly level. These were all good instruments, but were mostly useful by way of comparisons, which these makers have more recently developed by their improvements.

D. & F. E. Skeels show two steel tapes for the purpose of exhibiting their manner of doing up a tape without the trouble of carrying a reel.

Your committee is in favor of the GOSPEL—the Gospel of "Good Roads." If any member does not understand this let him take home a copy of this most commendable new monthly and study it. Not only so, but show it to others.

The "Compass," a monthly journal of much interest to engineers, is also shown, and every number will be found replete with descriptions of improvements and good suggestions.

GEO. E. STEELE,
DORR SKEELS,
ERNEST SELLERS,
Committee.

MISCELLANEOUS DISCUSSIONS.

TIME OF MEETING.

MR. HODGMAN: There doesn't seem to be anything special before the meeting just now, and I would like to get the opinion of the members present, in regard to the time of our meeting. Would it not be a good plan instead of having it the third week in January, to have it the week in which New Years comes? It would not then conflict with the meetings of any of the other surveyors' associations. Last year, if I recollect aright, Michigan, Indiana and Ohio surveyors met at the same date. Mr. Holmes, of Batavia, wrote me to know why we did not arrange our meetings so that he and other instrument makers could attend all the meetings. This year only Michigan and Ohio are in session at the same date.

Another thing is that the Michigan railway association refuses any longer to give this Society any reduced rates except upon terms which it is impossible for us to comply with. But they give reduced rates to everybody during the holidays, and if we should have our convention at that time we could have the benefit of them.

MR. APPLETON: I should be very sorry to see the meetings of the convention so near New Years. How long do these holiday rates extend?

MR. HODGMAN: I don't know, but I guess not over four to six days.

MR. APPLETON: I don't think the attendance would be apt to be any larger—take it the same week New Years is in. Now New Years may come on Tuesday or Wednesday, and I am sure I should feel bound to be at home on New Years, and I think there are others who feel just the same, and that would stop attendance, and I should be very sorry to see it changed to the same week New Years comes, unless New Years should come Saturday or Monday. The question is, however, whether the holiday rates extend so far.

MR. TODD: There is one reason why I should be sorry to see our meeting between Christmas and New Years—because every other year, we are in session at the State capitol and I would like to be there when the legislature is in session. But it may be for the profit of our Society to meet at the time the legislature is in session—we may have something we want to bring before our members, and if we are in session, members who being acquainted with the members from our districts, may possibly bring a force to bear that we could not otherwise.

EXCURSIONS.

PRESIDENT: The matter immediately before you is the excursions. We meet here at two o'clock in this room, when you can take your choice of six different excursions, with the proviso which I will add at the conclusion of my remarks:

To the Soldiers' Home, conducted by Dorr Skeels.

Excursion to Michigan Masonic Home, F. E. Skeels.

Excursion to Grand Rapids Brick Company's grounds, Mr. Ames.

Visit to the furniture factories, conducted by Mr. Christ.

Visit to Street Railway Co.'s electric power house, Mr. Owen.

Inspection of the pavements, and visit to points of interest in the city; the city engineer, Mr. Collar, will be conductor in charge.

There will be an opportunity to inspect the City Railway Company's electric power house: Either one of the first three excursions may be combined with this visit—Soldiers' Home, Masonic Home, Brick Company's grounds—either one of these three may be taken in connection with the visit to the electric power house.

MR. APPLETON: There will be no time, I understand Mr. President, to see anything else, if you take either of these two this afternoon.

PRESIDENT: You must make a choice in the list. I have given you a limit of the choice as well as I am able.

MR. SKEELS: The local committee has seen fit to inflict on the members of this organization something in the shape of a

souvenir, an album with views about the city. They are brought in at this time because some of the members cannot stay with us any longer, and we wish every person connected with the society or with engineering in any way, to appropriate one of these to himself, whether he be visitor or member, presented with the compliments of the city of Grand Rapids. The board of trade has entered into the scheme with us, and present you with copies of their pamphlet.

MR. AMES: I am informed that the Alabastine Company would like to show their works while we are at the Brick Company's works; and also, that in order to combine, as the President mentioned, the first three excursions with the last, it will be necessary to take in some one of the first ones, and we can visit the electric power house when we come back.

PRESIDENT: The presentation of these souvenirs and these publications from the board of trade, will undoubtedly be gratefully received by the members. I have no doubt they will prove not only a sentimental souvenir of Grand Rapids, but a very practical, useful one in some respects, and I would say to the gentlemen who have been so kind as to provide these things for us, that we thank you heartily for them.

AFTER THE EXCURSION.

THE PRESIDENT: One matter which I have neglected, I wish to call your attention to, and beg pardon. I see upon the table here a few books. Here is one, "Notes on Rankine's Civil Engineering," and if any of you think you can read Rankine without notes, you will think differently before you get through. This is one of those books of the utmost practical benefit.

And while I do not wish any man any harm, I wish Prof. Greene was not here, so I could tell you how good a book that is.

Here is a new edition of Mr. Hodgman's book on "Land Surveying" which as you know I have said so many times, is absolutely unique of its kind.

Here is another on "Separate System of Sewerage" by our member, Mr. Pierson, fully as good as the other two, If you want good books, there are three.

There are quite a lot of photographs and matter of that kind for your examination, in which I feel sure you will be interested.

There may be some who have not been here before, and I will say that there are numbers of copies of "The Compass" with which you may supply yourselves and a book, supplied by the Grand Rapids board of trade, views of this city, of which you may have copies as far as they go.

I hope also that you all had as good a time this afternoon as I did, and as much better as you could appreciate. I think we are under many obligations to the local committee and to the engineers of this city, for the exceeding pains and care they have taken in endeavoring to make our stay not only pleasant, but extremely profitable. I have heard more than one person say that they had stored up thoughts and suggestions and ideas and information generally, the whole afternoon through, and I wish it could be conveyed to Mr. Chapman, how fully we appreciate his kindness in lecturing to us by the hour, in giving us information and showing us about the electric light plant. I assure you gentlemen, and I assure him through the local committee, that it is appreciated especially by those of us who have much talking to do, and if he was a little thoughtless about it, he will appreciate it by morning, that he has done a hard day's work.

LEGISLATION.

The Secretary presented and read a letter from W. R. Coats desiring the Society to take steps towards securing the passage of a law requiring hydraulic engineers to pass an examination and receive a certificate of qualification before being permitted to practice in the State:

MR. TODD: There is a matter I would like to speak of as it has been brought up by the communication from Mr. Coats, in regard to the Society taking some action in licensing engineers, municipal and hydraulic. I think there is a crying need that the county surveyor be a licensed man. If there is any man that is subject to wire pullers, it is the county surveyor, and I think if there is any man that may be placed in a position of

responsibility without any consideration of his efficiency whatever, it is the man that is elected county surveyor. We have attempted some legislation in this matter and by the rather discourteous action of the members of the legislature, it was set at naught. I trust some action may be taken in this matter as all of us acquainted with the facts in question, know the importance of having a competent man in that place and know of the frequent incompetency of the incumbents.

MR. HODGMAN: This is a matter in which surveyors and civil engineers all over the country are interested and a line in which many of them have been working for years. I have been written to on the subject by parties in California, Missouri Arkansas, Illinois, and other states, all having the same end in view. They all meet with about the same kind of success so far as I can learn. Nearly every surveyors' association has started out as we did by going through the performance of preparing bills which they have asked their legislatures to enact into laws. But the legislatures have not done it. The bill that we presented to the legislature was treated with great contempt by the committee to whom it was referred and the most galling thing to me about it was that the report of the committee was written by its chairmam—a *county surveyor*, and anything but a competent one at that—to my personal knowledge. The result of it was that we went to work as a society with the principal aim to improve ourselves and to improve the profession. We have done good work in that line. Our work has made better surveyors and better engineers not only all over our State, but all over the United States. Our work has made itself felt all over the United States and Canada and because of what we have done the average county surveyor the country over is a great deal better man than he was before we began our work. And we are not only making better surveyors but we are making better lawyers too. At the same time I confess I do not see any great object in trying to pass laws for licensing surveyors and engineers or any great prospect of it either.

PRESIDENT: I am of the opinion that until the county surveyor has the licensing of the lawyer, it won't be any use to

license the county surveyor. License the county surveyor all you want to, and then license the lawyer.

MR. STEELE: This talk takes me back to the organization of the Society, when we were trying to make a change in the system of election of surveyors, and to get some one who should hold the office of county surveyor who knew how to perform its duties. We could see that men were elected to that office without the slightest knowledge of the business, and there were glaring defects in the laws. We made comparisons with other professions, in which men were obliged to pass examination before practicing. The druggist must be examined before he puts up poisons, but anyone can go out in Michigan and establish lines and make people trouble. He can measure land with a piece of cord, and it is just as legal as work done by the other fellow with a $10 tape.

But when you undertake to get the legislature of Michigan to move in this matter of examination of this officer, or any other surveyor, whether he be elected to the office or not, you will find a good many things in the way. First, who is going to examine him? A board, you say. Another board to be formed. More expense. We can have fish commissioners, and hatch white fish by the million, and the expense is not counted, but when we are talking about making the work of the surveyor more useful and valuable to the owners of property, then we are set at naught. We are trying to turn the cone over onto its apex and make it stand. We can't do it.

Now, I believe this Society did conclude a long time ago that it would allow the poor county surveyor to do just as he had a mind to. They would read up and talk it up and go home and practice what they had learned, and let him do the same. In other words they would improve themselves, and if possible improve him, and every man in the State, without regard to condition or color; try to get him up into a better condition than he was. That is the work of this Society. It is not to put down anybody or deprive anybody of his office, but to help him up. Keep up a big whirlwind here, that will draw in others from all around. Let him see there is something in this work, that we are here for business, not pleasure, and they will be enthused in a little while to join with us.

That is what we want. The more the better. As Mr. Hodgman has said, the condition of every surveyor is far better than it was ten or twelve years ago in this State. His responsibilities are no less, but his opportunities and privileges are greater. What can he do now? By joining this Society, he can get the reports of this and other societies, and gentlemen, I would not take a good many dollars for those folios. I have had them all bound this year, and they make a nice row, and if there is anything I value it is that set of Engineers' Reports. Every time we meet we are making a new report and we are making something we can look at with pride, and I think in that respect, we can invite with a good conscience every man to join us.

Hence, I say I would be opposed to another effort towards working through the legislature at this time, to do away with that office or introduce any system of examination. Not because I don't think it would be good, but because I think it would be an utter waste of time to spend it upon a legislature that would not do anything. They turned their backs to us, and when we, with the utmost respect, sent them our memorial asking to have something done, the committee had the indecency to not even report it. I have never forgotten it, and it will be a long cold day when I sign my name to any other memorial in that line.

MR. TODD: I know that the Michigan Engineering society is making itself felt, even in our legislature. I wish to say that at our last meeting at Lansing, I went to see the senator and representative from our county, and said our society was in convention, and invited them to attend, and they did attend and expressed themselves very much surprised indeed and very much pleased, and further said if there was anything they could do to advance the interests of the society, that was reasonable, they would willingly and gladly do it. Now, I think if every member of this society will take the member of his section in hand, he could manipulate him to good advantage. I think we can bring the matter before them so they can see the equity of it. They are made of the same stuff we are, and I think there is an element of justice even in our legislature.

BUSINESS TRANSACTIONS.

PRESIDENT: Gentlemen, the secretary reminds me that we have a little business to do, and I will trust him to tell you what we have to do. Mr. Secretary you have the deck.

MR. HODGMAN: The officers of this society should make their annual report. Nominations are to be made for officers for the ensuing year, and an amendment to the by-laws, has been submitted to the board of directors which should be acted upon. In order to post the society on what was done at the annual meeting of the board of directors, I will say that the meeting was appointed in accordance with the law, at Lansing, the second Wednesday of October. Only two members of the board of directors were present. They adjourned the meeting to Ann Arbor, where a majority of the board of directors live. I was unable to attend in person, but I received this report of the doings of the board of directors at that meeting:

REPORT.

MICHIGAN ENGINEERING SOCIETY. BOARD OF DIRECTORS. ANNUAL MEETING.

The directors met pursuant to adjournment from Lansing, October 14 to meet in Ann Arbor the week following because of want of a quorum. They met at the residence of Prof. Chas. E. Greene, October 22, 1891, at 7 p. m. Present: Prof. C. E. Greene, Prof. M. E. Cooley, and J. B. Davis directors, and Profs. W. H. Pettee, C. S. Denison, and Mr. Fred Morley members. J. B. Davis was made chairman of the meeting. The secretary, Mr. F. Hodgman, not being able because of ill health to be present, Mr. F. Morley upon being requested by the directors acted as secretary pro tem. for this meeting. From his notes this record is prepared. The members present were invited to take part in the labors of the meeting and did so, much to the aid and gratification of the directors. The first business was canvassing ballots. There were chosen by letter ballot a president, a vice president, a secretary-treasurer, and

three directors. Professors Pettee and Denison were made tellers to assist Professors Greene and Cooley in making the canvass. Two tally sheets were kept.

All the names and votes were canvassed at once. The following is the result: Sixty-three ballots were counted. Two or three could not be counted because it was impossible to discern the voters' choice. One such is preserved showing every name checked. Some others could be counted only in part, for the same reason, the voters' choice could not be discovered from the marks:

For president—Prof. W. F. Durand, 59. Elected.
For vice president—Prof. M. E. Cooley, 37. Elected.
Hon. Geo. E. Steele, 24.
For secretary-treasurer—F. Hodgman, 63. Elected.
For directors—Prof. C. E. Greene, 50. Elected.
Hon. Geo. E. Steele, 33. Elected.
Prof. J. B. Davis, 39. Elected.
Mr. A. J. Teed, 24.
Wm. Appleton, 23.
G. S. Williams, 9.

After full discussion by all present, the directors voted unanimously to hold the next annual convention at Grand Rapids, to begin January 19, at 2 p. m., and continue through the 20th and 21st.

The directors were pleased to receive notice of the following papers for the coming convention and signified their approval by unanimous vote: Sewerage of Dayton, Ohio, Geo. S. Pierson; Hydrographic Surveying, J. H. Forster; Developing Water Bearing Strata for Irrigation or Water Supply, A. L. Reed; Opinion of U. S. Supreme Court on the Ownership of Lake Beds, F. Hodgman; Pneumatic Street Railway Propulsion, S. E. Jarvis; Building Stones, second paper, W. H. Pettee. It was also announced that papers could be expected from Prof. M. E. Cooley, probably on Radiator Tests; Prof. C. S. Denison, probably on Idaho Boundary; Mr. Fred Morley, probably on Survey of Grand river.

Copy of an amendment to by-law six was submitted in writing by F. Hodgman, as required by by-law nine, which was received and filed.

A request was made that Mr. Steele furnish the society with

such information as he is able to relating to the State boundary between Ohio and Michigan, laws, acts, commission work or any matter that he may deem important, that the members may become informed of what has been done relating to this line. Indorsed by the directors. The report of the secretary, Mr. F. Hodgman, was received, read and filed. The report of the treasurer, Mr. F. Hodgman, was received, read and filed. Both reports covered transactions for the preceding year. Bills for actual expenses of the board of directors for this annual meeting for 1891 were allowed and ordered paid.

The secretary was instructed by vote to correspond with the local members relative to making the preliminary arrangements for the coming annual convention at Grand Rapids.

The directors then adjourned.

FRED MORLEY,
Secretary pro tem.

per J. B. DAVIS, *Scrippo.*

The following are the reports made to the board of directors:

ANNUAL REPORT OF THE SECRETARY.

Your secretary would respectfully report the following business transacted by him for the society since the last annual meeting. Immediately after that meeting, arrangements were made and program made out for the annual convention. This was held in Lansing in the pioneer room of the capitol building. The secretary was unable to be present at the convention and the stenographer's report was of so little value that no use could be made of it. For this reason the reports in the Annual both of business transactions and discussions are of the briefest. No report whatever was made of the addresses by Professors Greene and Denison. The contract for printing the Annual was let to the Review & Herald Printing company of Battle Creek. The preparation of the copy was delayed by reason of the want of a suitable report of the proceedings and the publication was further delayed over a month after everything else was in print to secure the advertisements. In

consequence of these delays the annual was not out till July 24, at least two months later than it should have been.

A table of contents of the entire series of annual reports was prepared, but owing to a misunderstanding on the part of the printer was bound separately. I had a sufficient number pasted into the reports for our own members, and have sent out a considerable number of them to surveyors and engineers in the hopes of increasing our membership and the sale of the reports.

I have thus far received only the following exchanges namely: The Technic, the Technograph and the Iowa reports. The report of the Dominion land surveyors has been sent me and now lies in the express office at Climax. The charges are about three times as much as they ought to be and I have refused to take the package until the matter can be adjusted.

There are now on our list 18 members who are two years behind with their dues, 20 who are one year behind and two whose senior membership fee is in arrears. The membership of these two is forfeited according to our by-laws.

The secretary is of the opinion that there should be a by-law by which membership may be forfeited for non-payment of dues or assessments.

F. HODGMAN, *Secretary.*

TREASURER'S REPORT.

RECEIPTS.

Cash on hand Oct. 8, 1890	$73 54
Received from advertisers	264 50
Received from application and membership fees	58 00
Received from dues	208 00
Received from reports sold	3 50
Total	$607 54

EXPENDITURES.

Paid for publishing annuals	$288 11
Paid for postage and envelopes	24 40
Paid for express and freight	5 00

Paid for printing circulars, ballots, envelopes and programs	$13 00
Paid expenses of board of directors	22 77
Paid secretary for salary	100 00
Paid for American Digest and reports	6 25
Cash on hand	148 01
Total	$607 54

The society owes nothing. There is due it from members, $116; from advertisers, $49. A considerable part of this amount will probably never be paid.

F. HODGMAN, *Treasurer.*

SECRETARY'S REPORT TO THE CONVENTION.

Supplementary to these reports the secretary would add that he has sent copies of all the exchange reports received to every member of the society who was not in arrears for dues. The Technograph has been added to our list of exchanges. Missouri seems to have dropped out of our list permanently for some unknown reason. I have not been able to get any communication from the secretary of that society for several years, although I once registered a letter to him to be sure he received it.

Arkansas reports also have failed to show up, for what reason is not known.

Invitations to attend this convention were sent to every surveyor and civil engineer in Michigan whose address I could procure. A large number of blank applications for membership have been sent out some of which have been returned signed.

I would suggest the question whether the interests of the society would not be promoted by changing the annual to a monthly. Suppose that instead of publishing our papers all at once, we take one at a time in its suitable season, send out proofs of the paper and its discussion to selected members of the society for their criticism, and perhaps add matter to the point from our exchanges; all together to make the leading matter

for the number. Add to this personal notes of the work and wants of our members, and condensed engineering news of the month. What do you think of it?

Lastly I would suggest the question, is it not now the time for us to begin a movement for the benefit of the society at the world's fair?

F. HODGMAN, *Secretary.*

SECRETARY: Reports are not sent to any members who are in arrears, and if any member hasn't received his reports he must know one of two things, they were either lost in the mails, or he is in arrears for dues. I have learned of several cases where they have been lost in the mails, and for one or two years, we have sent the exchanges by express.

You have in the proposed amendment to the by-laws means of terminating the membership for non-payment of dues. I will read it here. It was presented to the board of directors, and it is now presented here and you will be asked to act upon it. It is proposed to amend by-law No. 6 so as to read as follows:

6. A member may be reprimanded for not contributing to the papers or discussions of the society, after being officially requested; or for just cause may be expelled from the society by a three-fourths vote of those present, but not without due notice to appear for his defense. Any member who fails to pay his annual dues, or any assessments levied by the society, within two years after the time when such dues or assessments are required to be paid, shall thereby forfeit all his rights as a member, and his membership may be annulled. It shall be the duty of the board of directors at their next annual meeting thereafter, to declare all such memberships annulled, unless at that time the arrearages shall have been paid, and satisfactory reasons given why such action should not be taken. Notice of such required action shall be sent to every member who is two years in arrears, by letter, to be mailed to his last known address, at least one month before the time of the meeting of the board of directors, at which such action is to be taken.

PRESIDENT: Gentlemen, suppose we dispose of these reports first. Suppose we first dispose of the secretary's report, as secretary. What will you do with it?

Moved and supported that the report be accepted, and carried unanimously.

The usual disposition I believe of the treasurer's report is to appoint a committee who shall settle with the treasurer. Is that right Mr. Secretary.

MR. HODGMAN: The board of directors usually do that.

PRESIDENT: What shall we do then with the treasurer's report? It has been before the board of directors and received their approval.

It is moved and supported that the treasurer's report be accepted and adopted. Are there any remarks? Hearing none, etc., the report is accepted and adopted.

PROF. COOLEY: I would like to know the assets.

MR. HODGMAN: Cash on hand at the present time, or before this meeting commenced, was $151.01.

PROF. COOLEY: I mean, what we may expect from the members. What are we worth in your judgment?

MR. HODGMAN: I don't understand the full scope of Prof. Cooley's question. We don't owe a cent to anybody.

PROF. COOLEY: What I meant was, how much of that which is still due the society may be still collected. Have we $200 in other words?

MR. HODGMAN: Of the amount reported in October as due, there was about $49.00 for advertisements that has all been collected but $16.00. Six dollars of that was due from G. S. Woolman who has failed, and the rest from the Michigan Car Co. of Detroit. Some portion of the dues from members has also been paid and if it would serve any good purpose I could give the names of those who are in arrears, and the length of time they are in arrears, and the members could judge for themselves. There are a number of members whom we cannot find or hear of, who are a good deal behind and at this time there is standing out $132 due the society from members, but I don't suppose half of it will ever be paid.

PROF. COOLEY: Making about $250 if we can get half of it.

PRESIDENT: You have heard this amendment to the by-laws read, which has been duly submitted to the board of directors, as is required. What shall we do with it?

It is moved by Col. Muenscher and supported that this by-law be adopted.

MR. STEELE: Mr. President, on that question I would like to say a word. I want to understand whether this liberates any member from any obligation he may have, by his simply failing to pay his dues? We are an incorporated society and every member is liable for his share of our debts if we have any. Now if a member sees the pressure is a little too much on him all he has to do is to neglect to pay and be relieved of all responsibility. That won't do. We want at the same time to relieve the Society of responsibility.

MR. HODGMAN: It does just that. Now here are men who haven't been in practical affiliation with the society for years. They don't help us in any way. If we are in debt, we fellows have to carry them. We are paying their share of the expenses right along. We can't reach them, don't know where they are, and I think there should be a way by which those fellows can be dropped out of the society, and all their rights terminated. When that is done, all their responsibility terminates.

PROF. COOLEY: No way of keeping responsibility and sacrificing rights is there?

PRESIDENT: Are there any further remarks? If not, I will put Col. M's motion, that it be adopted. Those in favor, etc.

The by-law is adopted.

PRESIDENT: I think it is proper to make our nominations. We have to nominate president, vice president, secretary and treasurer, and three directors.

I would say that Prof. Durand was notified of his election as president, and immediately sent his resignation, and it was considered the better way, under our by-laws, that the old president should hold over.

Some persons who have just passed in their applications to be voted on will very likely have an opportunity to vote on these nominations, as the vote for members will be decided before the vote for officers, or may be. We nominate here at these conventions such persons as we see fit. These nominations are placed upon letter ballots and sent to every member. We nominate as many and such persons as we choose.

The following nominations were then made:

For president—E. W. Muenscher, J. H. Forster, Geo. L. Wells.

For vice president—Geo. S. Pierson.

For secretary and treasurer—F. Hodgman.

For directors—Dorr Skeels, Wm. Appleton, J. B. Davis, Geo. M. Ames, John K. Yocum, C. S. Denison, Guy H. Carleton.

MR. STEELE: Mr. President, I move that this society send a telegram announcing to Mr. Forster his nomination, and good cheer generally.

THE PRESIDENT: It is moved and supported that a telegram of greeting and congratulation to Mr. Forster, and of good will from the society, be transmitted to him by the secretary.

Hearing no remarks, those in favor of so doing, please say aye, opposed, no. The motion is carried.

MR. STEELE: Is our secretary to have any pay?

PRESIDENT: I will entertain a motion with respect to the secretary's compensation.

MR. STEELE: My motion would be then, that he be compensated the same as last year, $100.

PRESIDENT: It is moved and supported that the secretary be tendered $100 in payment for his services during the past year. Are there any remarks, etc. The chair would wish to say, that you can't pay the secretary. You don't own money nor property enough to do it, and the man who occupies this position, however unworthily, is in a position to know as no other member is likely to, the truth of that remark. Are there any further remarks? Hearing none, those in favor of drawing a check for Mr. Hodgman, for $100, etc. It is a unanimous vote, sir, and you can't escape.

MR. HODGMAN: I have to thank you. I never supposed that Prof. Davis would tell a wrong story. He said you couldn't pay me, but gentlemen, you have paid me, twice over.

PRESIDENT: I am certain that the compensation which Mr. Hodgman most heartily appreciates, is our active interest and co-operation in his endeavors to make this institution a blooming success. This is the kind of pay he likes.

Is there any other matter that you would like to bring up, gentlemen, before we adjourn?

MR. HODGMAN: I move that when we adjourn, we adjourn the convention.

PRESIDENT: Any remarks? Hearing none, etc.

When we adjourn, we will adjourn the convention.

PROF. COOLEY: I haven't had the opportunity, unfortunately for me, of being present as much, during this convention—

PRESIDENT: And unfortunate for us.

PROF. COOLEY: Kind of you, I am sure. But everywhere I have been, and every time I come here, I have felt impressed with the fact, that this local committee have done by us something perhaps that has never been done before. I think they have made us royally welcome, and have placed us in shape to do our work expeditiously and with great satisfaction and profit to all of us, and I should dislike to see this convention adjourn without an expression of thanks to this local committee, for what they have done for us, and I move that this society extend to the local committee their thanks, in as warm and appreciative a manner as possible.

Motion supported.

MR. HODGMAN: No one can feel more than I do, what this committee has done for us. Nothing could be done that has not been done.

PRESIDENT: That is the way I feel about it. It is just as nice as it can be, and I understand all the remarks to support that motion.

MR. STEELE: The effort of this local committee has been the means of giving me great pleasure. I have had the fortune to be conveyed over the city in a fine carriage, much better than I have at home. I have visited some factories here, and what is more than all else, I have been accompanied during all this trip by our worthy president.

PRESIDENT: That was what he meant when he started out, by his misfortune.

Any further remarks gentlemen? Hearing none, etc., unanimously carried. Any further busines?

PROF. COOLEY: I wish to say, what perhaps somebody ought to say, it seems to me that the press of the city is entitled to the thanks and consideration of this body, and also to the city

officers, who have extended to us the courtesy of these accommodations. I should like to make a motion to that effect.

PRESIDENT: Those gentlemen who can read, and have had the opportunity to read the papers (which I have not) can speak about the press in the manner which it deserves; but so far as I could judge by the interest in the meetings, manifested by the representatives of the press, who have communicated with me about the matter, I should say that they were entitled to our thanks decidedly, and I hope Prof. Cooley's motion is supported. Is it?

It is moved and supported that the thanks of this convention be tendered to the press of Grand Rapids for the cordial manner in which they have interested themselves in our proceedings, also to the officers of the city of Grand Rapids, for their courtesy in providing us quarters, making us welcome, and establishing conveniences of various kinds for our convention. Are there any remarks gentlemen? Hearing none, etc., it is unanimously carried.

Is there any further business?

MR. SKEELS: As chairman of the local committee, I wish simply to say that we are glad that you are glad, and we will be still more glad should you at some time in the near future hold another convention in this city. We will throw our present effort in the shade, if you will come.

Applause.

MR. HODGMAN: I have this to say to the gentlemen who have made remarks here, Mr. Bean among others, I should be glad to have them put the points presented on paper, and if there are any who have not furnished me the manuscripts of their papers, I should be glad to have them do so. If we have good luck, I hope to have the Annual out by the first of May. I was delayed, as I said, last year, by several unfortunate things. One was my own illness, and I had to do everything from a sick room. I was unfortunate in getting the advertisements together. If it hadn't been for Mr. Geo. Wells and Mr. Ames we should have fallen short of what we did, but those gentlemen boosted me right out.

But I want to say right here, that it will help a great deal in getting out a creditable report, if we can get lots of adver-

tising patronage, and I want every one of you who can help us in this way, to do it right straight now as soon as you can. I will furnish any one with blanks. Our regular rates are $10 a page, $6 half a page. Some pages for special advertisements more, but these are mostly full.

Mr. COOLEY: Yesterday some gentleman suggested the advisability of printing in our proceedings a list of the membership together with the especial work which they are accustomed to do. That isn't my thought, but on account of that it has occurred to me that I have seen in some of the engineering periodicals, little one or two line advertisements by professional men, giving the man's name and address and the particular service he engages in. Now if there will be twenty-five or thirty who will wish to have published in our proceedings such an advertisement, it would pay, and I for one, would be glad to pay what such an advertisement would be worth, in addition to my annual dues.

Mr. (?) I was thinking of that, only I was going to ask the secretary to make known the least possible living rates for members of the association. The probability is, you could get ten on a page, if not fifteen or twenty.

MR. HODGMAN: Of course the design of this whole business is to get as much money as we can to put into our report. Since I have had the handling of it, I have always aimed in getting out the Annual to keep it entirely within our means and incur no expense but what we had money to pay. Now, if we have more money, there are fine illustrations to be had. We can put in cuts and illustrations which simply stay out if we haven't the money.

By the way, there is one thing I should be extremely glad to do. Through our own Annual, and the publications of the Engineers' Society of the University of Michigan, we have had the portraits of several of our officers. Now it would please me most exceedingly if we could have in our next Annual the portrait of our late president, Mr. Steele.

MR. STEELE: I think it would injure the sale of the book.

MR. SKEELS: I think it would be well to give him notice so he can prepare himself for a sitting.

PRESIDENT: I am in favor of printing Mr. Steele's picture

as president of this society, and I hope we can carry a motion here to have it done. Now Steele, don't make up a face and spoil that picture.

MR. STEELE: When you get right down to solid business gentlemen, I think you might just as well leave it out, and while I would consider it complimentary, I also regard myself as a member of this society who has no such attainment as would make a way for my face in a book that you may get up. And you need not think a moment, because somebody else has been there, that while I have been honored by being your president, I would feel out at all if you never said anything more about it.

MR. SKEELS: Mr. President, I think it would be a good idea to get and publish pictures of the presidents of the association, and follow it down, each retiring president, and all those members who have been presidents, if we haven't got them, why get them, and state the year or years in which they held the office.

PRESIDENT: Very good idea.

PROF. COOLEY: I move that we have the picture of Mr. Steele put in the Annual.

PRESIDENT: It is moved and supported that Mr. Steele's picture be published in the forthcoming annual. Unanimously carried. There is one more matter which is a little serious and that results from the manner in which we record our minutes. Our whole batch of minutes for this whole convention must remain without being approved, by necessity, of course, as the minutes have been taken by a stenographer, it is impossible to have them prepared to present to the convention. The board of directors does not come together until October. We have passed a lot of motions and done a lot of routine business that ought to be tied up someway so that it will stand. We are an incorporated body.

I will entertain a motion to empower the secretary to prepare and publish the proceedings of this convention, subject to revision and correction, as the members may find necessary, before the convention.

Mr. STEELE: The only change in your view would be, in my estimation, that he ought to be empowered, wherever he may

think it important, to condense the proceedings. We possibly have a good deal that it would not do to print in the proceedings.

Motion made to that end.

PRESIDENT: It is moved and supported that the secretary be empowered to prepare and publish the minutes of this convention as the official minutes thereof, subject to future revision and reconsideration before the convention at its future sessions, if any member finds it necessary to do so.

Are there any remarks, etc. It is carried.

PROF. COOLEY: Again referring to the fact that I have been so unfortunate as not to be here during the entire session of the convention, I have been informed that our stenographer has been very successful in taking the notes of our meeting. I move that a vote of thanks be rendered her.

PRESIDENT: It is moved and supported that the stenographer receive the thanks of the association for her diligence and success in recording and preserving the minutes of this convention, beside her regular pay.

Any remarks. The motion is carried.

Is there any further business?

It is moved and supported that we do now adjourn.

This convention is adjourned.

MEETING OF BOARD OF DIRECTORS.

A special meeting of the board of directors was held on Thursday, January 21, at which applications for membership were approved and classified as follows:

For senior members—H. O. Duerr, James L. Rumsey, F. E. Skeels, J. J. Hubbell, John F. Meighan, Jas. R. Thompson, E. U. Hunt, Henry E. Riggs, Wm. G. Fargo, Henry H. Porter.

For junior members—D. J. Albertson, John Randall, C. B. Chynoweth, Joseph A. Watson, T. O. Williams, F. H. Williams, A. S. Calkins, F. L. Church.

F. HODGMAN,
Secretary.

CONVENTION NOTES.

Mr. Geo. M. Ames, assistant city engineer, exhibited a testing machine owned by the city, and demonstrated the manner of testing cement; making and breaking briquettes.

Mr. Van Amberg, who has charge of repairs on city works, exhibited two machines used in tapping pipes, and explained the manner in which they are used.

Letters were received from members Ripley, Brown, Pelham, Masson, Reed, Pearsons, Bellows, and Bigler, expressing great interest in the work of the convention and a desire to be present.

A letter was received from Wm. M. Whitten, introducing Mr. John F. Meighan of South Bend, who read an interesting paper on the calculation of earth-work and exhibited some tables of his own computation. The paper was received with great interest by the convention but was not furnished for publication.

Mr. Whitten also suggested holding the next convention at South Bend in conjunction with the Indiana engineering society. Owing to the custom of holding alternate conventions at Lansing, it was thought best not to make a change for the next meeting.

A telegram of greeting and good will was sent to the Ohio society of surveyors and civil engineers in session at Columbus, Ohio and a similar response received from them.

Prof. M. E. Cooley exhibited several fine instruments and explained their use—among others a Webb adder, a fine Aneroid barometer of great sensitiveness, a planimeter and an indicator for timing the revolutions of a shaft.

The stenographer's notes of Prof. Cooley's remarks were sent him for revision and as they have not been seen by the secretary since, he infers that they are buried under the immense mass of other matters which are so tremendously overworking the genial, kind hearted professor.

Messrs. L. Beckmann of Toledo and Keuffel & Esser of New York had fine exhibits of transits and levels. A number of other instruments owned by the city and by the local members

were on exhibition, making a fine display. A considerable number of copies of the "Compass," a monthly pamphlet published by Messrs, Keuffel & Esser, were distributed among the members. Everybody who uses surveying or draughting instruments ought to take the "Compass." Price $1 per annum.

By request of President Davis a motion was made and adopted making H. A. Collar, city engineer of Grand Rapids, an honorary member of the society.

The local committee "beat the record" and gave the members of the convention a magnificent reception. Nothing that could be done for the comfort or pleasure of the members was left undone, and the convention most heartily appreciated it. Messrs. F. E. Skeels and Geo. M. Ames were prominent in the good work.

Mr. A. L. Reed sent some fine photographs showing details of the construction of irrigation works of which he is engineer and manager in Whittier, California. The water is obtained from wells and carried in a canal which is lined with cement.

A committee consisting of Messrs. Hodgman, Steele, and Cooley were appointed to take measures looking to the benefit of the society during the world's fair at Chicago.

It was understood that some kind of an organization was being effected at Chicago for the benefit of engineers during the fair and that it might be well to look into the matter and perhaps take a part in it. The chairman visited Chicago during the convention of the Illinois surveyors and engineers and while there met Mr. Weston, secretary of the western society of civil engineers and learned from him the condition of the organization at that time. Members of various engineering societies have joined in the movement and effected an organization. It was proposed to expend $15,000 or more in providing for an engineering headquarters in the city—the money to be raised by an assessment equivalent to $2.00 for each member of the various societies concerned in it. No member of these societies to be admitted to the benefits without a ticket from the secretary of his society showing that his $2.00 has been paid. The secretary of the western society evidently has a very poor opinion of the State engineering societies, and the chairman of the committee is of the opinion that the Michigan society

will best maintain its self-respect by doing what it can for its own members and not seeking to join the Chicago organization without an invitation.

LEGAL DECISIONS.

From reports published by the West Publishing Co. of St. Paul, Minn.

1. A corporation platted an addition to a city. The plat showed on the north side a strip 85 feet wide, marked "North." An agent of the company, who was also a director, sold lots fronting on the strip, and told the purchasers that it was a street. Houses were built on either side, and it was used as a street, the city constructing bridges and sluices thereon. *Held* that the evidence was sufficient to sustain a finding that there was a dedication.—*Hitchcock vs. City of Oberlin (Kan.) 26 P. 466.*

2. Where a corporation platted an addition to a city, and the issue is whether a certain strip was dedicated as a street, statements made to that effect by a director of the corporation while selling lots as its agent are competent, but not while selling lots of his own.—*Hitchcock vs. City of Oberlin (Kan.) 26 P. 466.*

3. In 1853 the owner of land in defendant village platted the same into lots and streets, and caused a map thereof to be made. In 1875 one of the lots was conveyed to plaintiff by a deed which described it as bounded by one of the streets in question, which had not then been opened. Plaintiff took possession of the lot, including the street on which it was described as abutting, and cultivated it until 1887, when defendant opened the street. *Held*, that the act of plaintiff in occupying such portion of the street was not a revocation of the dedication, since her deed recognized the street.—*Rathgaber vs. Village of Tonawanda, 13 N. Y. S. 937.*

4. A plat of lands, made by the owner, showing lots, blocks, and streets, but not acknowledged and recorded as required by 2 Terr. Laws, Mich. 577 (1 How. St. c. 32), does not operate

as a statutory dedication of the fee of the streets to the county in trust for the municipality intended to be benefited. 47 N. W. 600 affirmed.—*Village of Grandville vs. Jenison (Mich.) 49 N. W. 544.*

5. In order that a plat showing lots, blocks and streets may operate as a common law dedication of an easement in the street to the public, there must be an acceptance by the public within a reasonable time; and it acquires no rights in a platted street which it failed to use for 34 years, during a part of which time an abutting owner occupied the same by buildings erected thereon, 47 N. W. 600, affirmed.—*Village of Grandville vs. Jenison (Mich.) 49 N. W. 544.*

6. Where the proprietor of land sells lots with reference to a city map showing the land as laid off into streets and blocks, he dedicates the streets as designated thereon to the public, to be opened whenever the public authorities may deem necessary, and when they are opened he cannot recover damages.—*Sherer vs. City of Jasper (Ala.) 9 So. 584.*

7. A deed described the boundary of the land conveyed as a line running a certain course, "about 865 feet, to a point on the shore of Long Island sound; thence running along said shore and sound as the same bend and turn easterly; and thence southerly, to their intersection with" another line specified. The distance named carried the line to low-water mark at a place where the tide ebbs and flows. *Held*, that notwithstanding the rule that only the land to high-water mark is conveyed by a deed naming as a boundary the shore of the sea or other navigable water, this description was sufficient to convey the land to low-water mark.—*Oakes vs. DeLancey, 14 N. Y. S. 294.*

8. The owner of land abutting on Lake Superior platted it, together with the shallows beyond the shore, and sold blocks with reference to the plat. *Held*, that the gradual encroachment of the water on one of the shore blocks, so as to entirely submerge it, did not vest the title thereto in the owner of the adjacent inland block.—*Gilbert vs. Eldridge (Minn.) 49 N. W. 679.*

9. Where the owner of land abutting on Lake Superior plats it, together with the shallows beyond the shore, and conveys an inland block with reference to such plat, the gradual

encroachment of the water until it reaches the block so conveyed does not confer on its owner the riparian right to reclaim and use the submerged blocks and streets.—*Gilbert vs. Eldridge (Minn.) 49 N. W. 679.*

10. The riparian right of the owner of lands on the shore of Lake Superior to reclaim, improve, and occupy the land submerged by shallow water, beyond the shore, may be disassociated from the shore-land by the act of the owner, so that a conveyance by him of the shore-land would not include such riparian rights as incident thereto.—*Gilbert vs. Eldridge (Minn.) 49 N. W. 679.*

11. Where the government conveys land on the bank of a navigable stream without reservation, the land over which the stream flows, as far as the middle line of the stream, and all unsurveyed islands between this line and the bank, pass by the grant, and the riparian owner cannot be divested by a subsequent survey and grant of the islands.—*Butler vs. Grand Rapids & I. R. Co. (Mich.) 48 N. W. 569.*

12. Patents by the general government of public lands bordering on streams are not limited by the meander lines. Following Schurmeier vs. Railroad Co., 10 Minn. 82 (Gil. 59) and 7 Wall. 272.—*St. Paul S. & T. F. R. Co. vs. First Division St. Paul & P. R. Co., 49 N. W. 303, 26 Minn. 31.*

13. Government patents of public lands bordering on streams navigable in fact, issued under the acts of congress providing for the survey and sale of the public lands, do not take to the middle line of the stream, but stop at the stream. Following 7 Wall. 272.—*St. Paul S. & T. F. R. Co. vs. First Division St. Paul & P. R. Co., 49 N. W. 303, 26 Minn. 31.*

14. To determine the division lines between separate holdings in the shallow waters of a navigable bay, of owners of land bordering thereon and located on a cove, from the extreme points of the cove draw lines at right angles to the shore or meander lines meeting at such points, bisect the angles formed by such lines, and extend the bisecting lines to navigable water of, say 15 feet in depth. The points thus reached will be the headlands of the cove. Connect the headlands by a right line. Divide this line into as many equal parts as there are feet in the shore line between the two points of the cove, the shore

line being divided into parts of a foot each. The proprietorship of the land-owners in the inclosed waters is shown by straight lines connecting the corresponding points of division, this rule being based on the assumption that the bisecting lines will reach navigable waters before they intersect.—*Blodgett & Davis Lumber Co. vs. Peters (Mich.) 49 N. W. 917.*

15. The calls in a conveyance of land by a riparian owner were: "Thence N. 8 degrees W. 26 9–10 poles to a stake at Ohio river marked 'I'; thence down said river S. 62 degrees W. 81 6–10 poles to a stake on point at mouth of French creek." *Held*, that the line along the river was low water mark, notwithstanding the facts that before the conveyance actual survey was made fixing the point at I, just over the river bank, and running thence a straight line to point at the mouth of French creek, leaving a space between it and low water mark, and that a diagram representing such surveying and straight line was made, and the further fact that the deed contained the clause that said calls were to be controlled by the diagram.—*Brown Oil Co. vs. Caldwell (W. Va.) 13 S. E. 42.*

16. In an action involving the location of a boundary line between the M. and the A. surveys, it appeared that the M. survey adjoined the A. on the north, and that the disputed line was located in each survey by reference to the south line of the P. survey, which was marked on the ground. The P. survey adjoined the M. on the west. The three surveys were made by the same surveyor. The calls of the A. survey, which was not shown to have been made on the ground, were as follows for the western and northern boundaries. From the S. W. corner "N. 10,017 varas, to a stake in S. B. line of the P. survey; thence E., passing S. E. cor. of said P. survey, and S. W. cor. of the M. survey, 15,500 varas, to a cor. in the prairie; thence S. 1,064 varas, to beginning." The west and south lines of the M. survey were described therein as follows: From N. W. cor. "S 3,685 varas, pass N. E. cor. of P. survey, 13,685 varas, S. E. cor. of same on N. line of A. survey, a corner-stone marked 'X'" giving bearings, etc.; "thence east, with said line, 8,797 varas to beginning." The course "N. 10,017 varas" in the A. survey would carry the N. W. corner of that survey 1,084 varas north of the south line of the P. *Held*, that the south line of the P.

being marked on the ground, and being called for in both the A. and the M. surveys, would control the courses and distances given therein, and the south line of the P., extended east, was the boundary between the M. and the A.—*Montague County vs. Clay County Land & Cattle Co.* (*Tex.*) *15 S. W. 902.*

17. A junior grant on a senior entry called for courses and distances only. It was not surveyed until after the grant, and then the lines were extended beyond the distances called for in the grant, and were marked on the ground. There was no notice given as required by code, *Tenn.* § *2020*, where one desires to establish the lines of his land. *Held*, that as against the owner of a senior grant on a junior entry, who had no knowledge of the survey and marking on the lines, the lines must terminate where the distance called for in the grant gave out.—*Bleidorn vs. Pilot Mountain Coal & Min. Co.* (*Tenn.*) *15 S. W. 737.*

18. Plaintiff's deed described the land as "commencing at a point 60 rods west of the northeast corner of section 8, * * * running thence west * * *." The north line of the section did not run due west, as indicated by the true meridian. *Held*, that the presumption is that the line commenced at a point west of the northeast corner of section eight, according to the true meridian, but may be rebutted by extraneous testimony.—*Reed vs. Tacoma Bldg. & Sav. Ass'n* (*Wash.*) *26 P. 252; Clark vs. Same, Id. 253.*

19. An entry contained a call "beginning at the east corner" of a certain other entry. A subsequent call was "so as to include the head-waters of S.," a certain stream. *Held* that, it being necessary to begin at the northeast corner in order to include said head-waters, the first call was made special by the second call.—*Bleidorn vs. Pilot Mountain Coal & Min. Co.* (*Tenn.*) *15 S. W. 737.*

20. By commencing at a point in the first of a series of surveys, and pursuing courses and distances, and occasional marked lines, a certain survey about 20 miles distant would be located about a mile from certain trees called for as a corner in the grant of such survey. There was no other call for a living corner in such grant. These trees were well marked, and were called for as a corner in three other grants made at about the

same time, so that the four grants would corner upon each other. *Held*, that said grant would be located with reference to the call for the trees as a corner.—*Bleidorn vs. Pilot Mountain Coal and Min. Co.* (*Tenn.*) *15 S. W. 737.*

21. In construing a deed describing land by the government survey the court must ascertain the corners of the survey as actually established, and not as they ought to have been established; but the presumption that the deed was intended to convey according to the established corners may be rebutted by evidence that the parties were mistaken as to the location of the government line, and intended to convey a definite tract.—*Squire vs. Greer* (*Wash.*) *26 P. 222.*

22. Plaintiffs' survey described the courses as running south a certain distance to the north boundary line of survey No. 138 and east along the northern boundary of No. 138 and No. 132; but according to the distance recited in the survey the west line would fall short of the north boundary of No. 138, leaving a strip of land between it and the south boundary of plaintiffs' survey. The survey of No. 132, made about the same time as plaintiffs' survey, called for the south boundary of plaintiffs' survey as its northern boundary, and other adjoining surveys made about the same time made it appear that such was the boundary line. *Held*, that the courses and boundaries will prevail as against the distance recited in plaintiffs' survey, making it extend south to the north boundaries of Nos. 138 and 132.—*Wyatt vs. Foster* (*Tex.*) *15 S. W. 679.*

23. When monumental calls in a deed are fully identified, and are sufficient in themselves to show the boundaries, the courses and distances may be entirely disregarded, and this rule is applicable, though it results in an excess of 150 acres in a tract described as containing 240 acres, the excess being mostly covered by water, and of little value when the deed was executed.—*McCullough vs. Absecon Beach Land & Imp. Co.* (*N. J.*) *21 A. 481.*

24. In an action to establish the boundary line between two lots, the evidence was conflicting, and the line was differently located by two surveys. *Held*, that a judgment that the true line was the one marked by a fence, which was supposed to separate the two lots at the time that plaintiff purchased from

defendant, should not be reversed for want of evidence to support it.—*Brooks vs. Allen* (*Tex.*) *16 S. W. 798.*

25. In ejectment to recover land claimed by plaintiff to be included in his surveys of swamp and overflowed land, and by defendant as being included in another survey to him, the county surveyor who made all the original surveys, and his successor, testified that the land was in plaintiff's survey, and there was a natural monument still standing at which the surveys were begun. The surveyor employed by defendant commenced at a stake which defendant told him was the section corner, but about which he knew nothing. *Held*, that the evidence warranted a finding for plaintiff.—*Burdell vs. Taylor* (*Cal.*) *26 P. 1094.*

26. Where adjacent owners are in doubt as to the boundary, and after a survey agree upon a certain line, their agreement is valid, and the line as established by it will be held to be the true one.—*Levy vs. Maddux* (*Tex.*) *16 S. W. 877.*

27. Where an agreement has established a disputed boundary, subsequent conveyances by the parties to the agreement and their privies by the same descriptions as those under which the title was acquired and possession held prior to the agreement will pass the title according to the agreed boundary. —*Smith vs. McCorkle* (*Mo.*) *16 S. W. 602.*

28. Having conveyed certain land to his children, reserving a life interest in himself, the father entered into an agreement establishing a disputed boundary. On his death the children made another agreement establishing the boundary on the opposite side of the land, and therein they referred to the boundary agreed on by their father as the basis from which measurements were to be made. *Held*, that the reference by the children to the line agreed on by the father, and their subsequent conduct in maintaining the line so agreed on, was a ratification of the boundary established by their father.— *Smith vs. McCorkle* (*Mo.*) *16 S. W. 602.*

29. In an action involving the location of the boundary line between the lands of plaintiff and defendant, it appeared that the lands were part of an ancient grant, and were wild, unfenced mountain land. The deeds to the parties referred to the "Livingston line" as the boundary, but neither deed con-

tained sufficient *data* to locate the line. At the time of the conveyance, 30 years before the action was brought, and before any controversy had arisen as to the Livingston line, plaintiff's grantor had a survey and map made of the premises conveyed to plaintiff, and also of an adjoining tract conveyed to one W. The surveyor, since dead, went around plaintiff's parcel, and pointed out to plaintiff the corners and monuments as he (the surveyor) had established or identified them. The map remained in the possession of W. Plaintiff's surveyor testified that he found some of the monuments which the deceased surveyor had established. *Held*, that the map made by the deceased surveyor and the deed to W., and certified copies of older maps of the patent of which the land in question was part, which were on file in the office of the Secretary of State, and on which the Livingston line was marked, were admissible, in the absence of better evidence, as indicating common reputation as to the location of the line.—*Donohue vs. Whitney, 15 N. Y. S. 622.*

30. Where a corner is found on the ground having bearings called for in the patent, which is shown to be the corner of the land as actually surveyed, but there is an inconsistency between this corner with the lines run thence and the calls of the patent, parol evidence is admissible to show that these calls were the result of a mistake, which being shown, the actual survey governs.—*Converse vs. Langshaw* (*Tex.*) *16 S. W. 1031.*

31. In an action for the value of timber cut from plaintiffs' land the complaint alleged that the land was known as the "B. League," and was described in the original grant as commencing at the northwest corner of the E. survey; that such call was a mistake, and was corrected by the original field-notes, which called for the commencement at the northwest corner of the B. survey, which adjoined the E. survey on the north; and that the timber was cut from the boundaries last described. The title referred to the field-notes for a description of the land. *Held*, that such field-notes were properly admitted in evidence to show the location of the land.—*Irvin vs. Bevil* (*Tex.*) *16 S. W. 21.*

32. In ascertaining the actual location of streets and blocks,

the initial point and base line of the survey are not necessarily more controlling, or even as much so, as other ascertained points in the survey.—*Orena vs. City of Santa Barbara (Cal.) 28 P. 268.*

33. An ordinance declaring certain stakes to be the initial points of a survey already made, and attempting to locate lines therein, is void.—*Orena vs. City of Santa Barbara (Cal.) 28 P. 268.*

34. In determining the bounds of a survey a call for another survey definitely located is properly ignored where, if followed, it will necessitate a total disregard of course and distance, and cause the remaining bounds both to conflict with several other surveys and to end so far from the starting point as to exclude about 1,000 acres from the survey.—*Cregg vs. Hill (Tex. Sup.) 17 S. W. 838.*

35. Where the question is as to the true location of a government corner, and whether a certain mound, pits and stake, testified to by witnesses, were the original marks of such corner, it is not error to admit evidence to show that such marks were years before, when they were very plain and distinct, generally regarded and recognized as indicating the original government corner; and to that end it may be shown that permanent improvements, as lines of trees, roads, buildings, public and private, were, when such indications were plain and visible, located with reference thereto as the true government corner, by persons who had no other interest than to locate them correctly.—*Arneson vs. Spawn (S. D.) 49 N. W. 1066.*

36. Comp. Laws Dak. § 689, which provides that a survey made by the county surveyor "shall be held as presumptively correct," applies only to a survey made, authenticated, and recorded as provided by the statute; and parol evidence by the surveyor as to where and how he established a government corner does not take the place of his official report, nor support the same presumption.—*Arneson vs. Spawn (S. D.) 49 N. W. 1066.*

37. In an action involving the boundary line of land, the original corners, as established by the government surveyors, if they can be found, or the places where they were originally so established can be definitely determined, must control, with-

out regard to whether they were located with mathematical correctness or not.—*Arneson vs. Spawn (S. D.) 49 N. W. 1066.*

38. The fact that a purchaser of land, holding and claiming ownership thereof, has not yet paid the consideration therefor, does not invalidate a parol agreement made by him with an adjoining land-owner fixing the boundaries between their land. —*Cavanaugh vs. Jackson (Cal.) 27 P. 931.*

39. Surveys Nos. 323 and 324 were patented to plaintiff's husband. In 1870 his agent employed one B. to survey No. 324, and one W. had him survey No. 323. B. did not find the corners called for in the field-notes, and located the lines by their relation to the lines of other surveys as shown by a land-office plat. Soon afterwards W. purchased No. 323 by the description given in the patent. In 1879 the bearing trees called for by the field-notes were discovered, and the lines were run in accordance therewith. The survey of 1870 gives the land in dispute to the intervenor, who claims under W., and that of 1879 gives it to No. 324. *Held*, that a verdict sustaining the survey of 1879 should not be disturbed.—*Koenigheim vs. Sherwood (Tex.) 16 S. W. 23.*

40. Surveys Nos. 323 and 324 were patented to plaintiff's husband. In 1870 his agent employed one B. to survey No. 324, and one W. had him survey No. 323. B. did not find the corners called for in the field-notes, and located the lines by their relation to the lines of other surveys as shown by a land-office plat. Soon afterwards W. purchased No. 323 by the description given in the patent. When he made the survey in 1870, B. divided No. 324 into lots. The plaintiff's husband conveyed two of the lots "as laid off by B.," and after the conveyance by W. to the intervenor the plaintiff, as her husband's devisee, conveyed other lots by reference to B.'s survey. W. and the intervenor have held possession of the strip in dispute since the purchase by W. *Held*, that it was for the jury to say whether she was bound by acquiescence in the line located by B., and a verdict in her favor should not be disturbed.—*Koenigheim vs. Sherwood (Tex.) 16 S. W. 23.*

41. It is competent to establish the lines and courses of a tract of land by showing where the surveyor actually ran when making the boundaries at the instance of the parties to the

conveyance, and with a view to its execution.—*Euliss vs. McAdams (N. C.) 13 S. E. 162.*

42. A junior deed is not admissible as evidence to locate the corner of land conveyed by an older deed.—*Euliss vs. McAdams (N. C.) 13 S. E. 162.*

43. Where a surveyor establishes two initial points on the ground itself, and from these the remaining surveys are plotted in on a map, and in the plot calls are made for a river, the true course of which the surveyor has mistaken, the surveys must be run out as plotted, the calls for the river yielding to course and distance.—*New York & T. Land Co. vs. Thompson (Tex. Sup.) 17 S. W. 920.*

44. Where a deed describes the land as bounded as follows: "Commencing on the road" at a certain point; "thence west ten rods; thence south four rods; thence east ten rods; thence north on the road to the place of beginning," the presumption is that the measurements commenced from the side of the road, instead of the center; but the acts of the parties, contemporaneous with the delivery of the deed, in fixing the monuments and fencing the lot as if the measurements commenced from the center of the road, are admissible in evidence upon the question of the construction to be given the deed.—*Dodd vs. Witt 29 N. E. 475. 139 Mass. 63.*

45. Where it is uncertain whether a call in a deed for a line parallel to the boundary of a certain survey means a line parallel to the main line of such survey, or to a short, irregular part thereof, the question is for the jury.—*Lecomte vs. Toudouze (Tex. Sup.) 17 S. W. 1047.*

46. A contract for the sale of land described the property as the N. ½ of the N. ½ of a certain lot. An informal memorandum, signed by the parties before the contract was drawn, described the land as above, and also as "the C. & G. block." The evidence showed that the lot was 150 feet long, and that the north 40 feet of it constituted the C. & G. block. *Held*, that the contract called for the north 40 feet of the lot, as the block was a fixed and permanent monument, which would control the other description.—*Lyman vs. Gedney, 29 N. E. 282, 114 Ill. 388.*

47. A surveyor, hired by a city to make a survey and divis-

ion into blocks and streets of its lands, the streets to be 60 feet wide, and the blocks 150 yards square, and the corners of the squares to be marked by stakes, made the survey according to contract, and actually located the blocks and streets, marking each block by a stake, many of which remained for several years. His return of survey was merely that the survey was made, as directed in the contract, but contained no field-notes, and made no mention of any initial point or base line. Thereafter the city had made, and adopted as official, maps which purported to show said survey. And certain streets as so surveyed and mapped were declared open. The city then deeded a certain number of square feet, describing them as in a certain corner of one of said blocks, and bounded by two of said streets. *Held*, that the lot was bounded by the streets as actually located by the surveyor, and that, the stakes showing the location of the block and street lines having been lost, and there being no evidence of the precise point where they had been placed, evidence of the boundaries of the street as actually opened and used was material.—*Orena vs. City of Santa Barbara (Cal.) 28 P. 268.*

48. The fact that the grantee of the land inclosed his full quantity of land within the block, taking as the street line the boundary as actually opened, and that he acquiesced in this line for many years before putting out his fence into the street as actually used, is evidence of the correctness of the boundary as opened.—*Orena vs. City of Santa Barbara (Cal.) 28 P. 268.*

49. The acquiescence or admission of the owner of land, made under a mistake as to his rights, will neither estop nor prejudice him from subsequently enlarging his possession to the limits of his deed, provided no actual adversary possession has intervened to defeat his title.—*White vs. Ward (W. Va.) 14 S. E. 22.*

50. In trespass to try title between adjoining land-owners, defendant testified that he had settled the disputed boundary line by oral agreement with plaintiff and her husband, and that a bend in the line was to be made to allow plaintiff to retain certain improvements she had made. The county surveyor testified that, at the request of defendant and plaintiff's husband, who stated that they had settled the disputed line, he

surveyed the line under their directions so as to leave plaintiff her improvements, and that they expressed their satisfaction with the line as run. The surveyor was corroborated by three witnesses as to the agreed line. The parties immediately erected a fence on the line, and each held possession up to the fence till the beginning of suit, 18 months afterwards. *Held*, that the parties had established the boundary by oral agreement.—*Lecomte vs. Toudouze* (*Tex. Sup.*) *17 S. W. 1047.*

51. On appeal from a survey of a disputed boundary line, taken three years after the making of the survey, it may be shown that by mutual agreement the survey was abandoned and new boundaries established; that the parties moved their fences to the new line; and that each continued to hold possession up to such line until the trial.—*Horton vs. Brown* (*Ind. Sup.*) *29 N. E. 414.*

52. A large tract of land was laid off, for the convenience of selling, into smaller tracts, by running a base line and laying down the division lines by protraction, which division lines were never actually surveyed. The coterminous owners of two of said tracts attempted to survey and mark the true division line between their lots, and in so doing a mistake was made in running said line so as to include a large portion of one of said lots within the other, there being no dispute as to the true boundary. *Held* that, when said mistake was discovered, neither of the parties, nor their grantees, were estopped to claim his rights, nor could it be construed as a license from the one party to the other to cut timber between the true line and the mistaken boundary.—*Hatfield vs. Workman* (*W. Va.*) *14 S. E. 153.*

53. An agreement between adjoining owners establishing their dividing line is not void though the parties were mistaken in believing that the agreed line approximated the real line.—*Lecomte vs. Toudouze* (*Tex. Sup.*) *17 S. W. 1047.*

54. A conveyance of riparian lands by metes and bounds, which on the river side are substantially coincident with high-water mark, carries, under Code, *Va.* § *1339*, all the right of the grantor to the strip lying between high and low water mark.—*McDonald vs. Whitehurst* (*Cir. Ct.*) *47 F. 757.*

55. The owners of a mill dam and pond conveyed land on the west side thereof, describing the boundaries in the deed as "running easterly * * * to low water mark, on the west side of Fox river, [the mill pond]; thence running northerly along the low water mark on the said westerly side of Fox river," etc. *Held*, that the grantees took only to low water mark, and not to the center thread of the river.—*Allen vs. Weber (Wis.) 50 N. W. 514.*

56. The fact that such deed reserved to the grantors the right to flow the strip conveyed does not indicate an intention to convey to the center of the pond, since the right reserved might have been to flow the land down to the low water mark of the pond only.—*Allen vs. Weber (Wis.) 50 N. W. 514.*

57. Where the grantees from owners of a mill-dam and pond of land on one side thereof, have acquired title only to low water mark of the stream; a subsequent act of the legislature, declaring the stream navigable, cannot affect the rights of the owners in the pond, or vest such grantees with title to the middle thread of the stream.—*Allen vs. Weber (Wis.) 50 N. W. 514.*

58. Where the last call in a grant of land is "125 poles, to the beginning." and the beginning point is established, the line must extend to or stop at it, regardless of distance.—*Cowles vs. Reavis (N. C.) 13 S. E. 930.*

59. Where the lines which inclose four surveys in the interior of a block of surveys are marked on the ground by interior lines of the block and by lines peculiar to the four surveys, the lines which separate them from each other cannot be located by marks on the lines which inclose the block.—*Ferguson vs. Bloom (Pa. Sup.) 23 A. 49.*

60. The returns of survey gave four interior tracts of a block of surveys a common corner, and made two of them adjoin the other two along the entire western sides of the latter. The returns of survey also showed the south lines of the northern pair to be parallel with their north lines, and both the north and the south lines to be continuous; but the work on the ground showed that their north lines did not form a continuous line, but that one of the tracts extend north a half mile further than the other, with well marked lines all the way around the projecting part, which were peculiar to that tract, and not com-

mon to or in any way affecting the location of the other tracts. By means of the marks of the original survey on the ground, and the presumption that lines returned as parallel are so in fact, the four tracts could be located as separate surveys, with rectangular figures, without disregarding the returns of survey, except as to the tracts having a common corner, and as to their adjoining along their entire breadth, which latter provision of the returns was shown by the work on the ground to be a mistake and impossibility. Treating the four tracts as constituting a subordinate or interior block, carved out of the larger one, and entitled to the application of the same principles for the adjustment of its interior lines, and drawing a line between the points in the exterior lines marking the divisions between the northern and southern pairs, the four tracts are given a common corner, but the provisions that the sides be parallel and the tracts rectangular are disregarded. *Held*, that the four tracts should be located as individual surveys, and not as forming a block.—*Ferguson vs. Bloom* (*Pa. Sup.*) *23 A. 49.*

61. Three adjoining lots, fronting on the south, one of which was on the southwest corner of a square, were of a number that had been carved out of a tract of land of which three subdivisions had been made for the grantees of two portions thereof and the owner of the residue, respectively, by the same surveyor at short intevals of time. The owner of the east lot built his fence to conform to others in the rear, that had been erected at random, and the owner of the middle one took possession of the quantity of land called for by her deed, west of said fence. In subdividing said land a stone had been placed in the eastern line of the original tract, and it was found by running a line west therefrom for the distance called for by the several plats that the west fences of the corner and east lots were 11 feet too far west, as well as those of the lots in the rear, which were of the same width. *Held*, that the owner of the middle lot was in possession of 11 feet of land belonging to the owner of the corner lot.—*Quick vs. Butler* (*Ill. Sup.*) *28 N. E. 926.*

62. Where each of two coterminous proprietors recognizes the ownership of the other, and that the tract of each is bounded by that of the other, the ascertainment of the true line between

them fixes the extent of their respective tracts.—*Phillips vs. O'Neal (Ga.) 13 S. E. 819.*

63. Where a division line between two tracts of land owned by different persons has been extended in the wrong place, and then expressly agreed that it should be the line between them or accepted and acquiesced in as the dividing line from 1875 to 1883, it becomes their established division line.—*Harrell vs. Houston, 17 S. W. 731, 66 Tex. 278.*

64. In ejectment to recover a strip of land, part of one of three adjoining lots, the owner of the middle lot testified that when she went to look at it before buying it she met a man, who said that a fence which was not on the line was the eastern boundary, and that he stepped the land off from it. There was no evidence as to who he was, that he knew of any dispute, and had authority to settle it, or that, when the owner of the adjoining lot acquired his title from the same grantor, he had any notice of an agreement that said fence was to be the eastern boundary of the middle lot; and when a dispute arose as to the western boundary thereof its owner mentioned no such agreement, but said she would move her western fence, if it were insisted upon. *Held,* in ejectment, that said facts did not constitute an estoppel *in pais.—Quick vs. Butler (Ill. Sup.) 28 N. E. 926.*

65. Plaintiff in an action to determine a boundary, traced title from a certain person to himself for the whole of a certain lot. Defendant gave in evidence a deed from the same person for the western end of the lot. The boundary was described with reference to several monuments. The courses and distances named were inconsistent, and showed an evident mistake. *Held,* that the burden was upon the defendant, and that, unless one or more of the monuments could be fixed, so as to establish the boundary within plaintiff's lot, plaintiff was entitled to recover.—*Henry vs. Huff (Pa. Sup.) 22 A. 1046.*

66. In trespass to try title, brought by the owner of the balance of the block to recover a strip of land in excess of the five acres conveyed to the grantees in a deed, a surveyor who made a survey of the land may testify as to his location of the boundaries of the five acres, though the survey was not made under order of court.—*Henry vs. Whitaker (Tex. Sup.) 17 S. W. 509.*

67. In an action involving the location of a boundary line between adjoining land owners, both parties claimed through the same grantor. On the trial, a bond of title to the ancestor of defendant was exhibited, which contained reservations of certain tracts previously sold to parties specifically named, but no mention was made of plaintiff. Plaintiff claimed that a bond had been made to him which was lost or mislaid. The testimony as to possession was conflicting, both parties claiming to have exercised ownership over the land in issue by occasional use of the timber thereon. Defendant showed that his ancestor had built a cabin on the land, which had been occupied by tennants who held under him. In a previous controversy plaintiff sued defendant for forcibly entering upon this land, and a verdict was rendered for defendant. *Held*, that a judgment for defendant was sustained by the evidence.—*Jones vs. McCrackin (Ky.) 17 S. W. 626.*

68. In ejectment the question was as to the location of a section corner. Plaintiff's evidence tended to show a government mound erected at the point claimed by him, and a survey by H. made in 1845. Defendant's witnesses testified that they lived in the immediate neighborhood in 1842, at which time the government corner was lost, the monument having been rooted up by hogs. Defendant introduced proof of a survey made by L. in 1851, by starting from a known government corner half a mile north of the point in dispute. *Held*, that a verdict for defendant was not against the weight of the evidence.—*Green vs. Mumper (Ill. Sup.) 28 N. E. 1075.*

69. The United States interior department, by a circular issued in March, 1883, gives the following method for the restoration of lost or obliterated corners of government surveys on base and correction lines: "Run a right line between the nearest existing corners on such line, whether base or correction line, which corners must, however, be fully identified, and at the point proportionate to the distance given in the field-notes of the original survey establish a new corner. This point should be verified by measurements to the nearest known corners north or south of the base or correction line, or both." *Held*, that the corner so established is not conclusive, and is not to be preferred to a survey between two fully identified

corners, with which, upon actual measurements, it fails to verify. —*Hess vs. Meyer* (*Mich.*) *50 N. W. 290.*

70. If the beginning corner in the description of a tract of land has been destroyed, it is proper, in order to ascertain the true boundary, to survey the land by beginning at any known corner or point from which the boundaries may be located. *Cowles vs. Reavis* (*N. C.*) *13 S. E. 930.*

71. Where a patent calls for unmarked lines of surrounding surveys, the position of which can be accurately ascertained, and there is no evidence as to how the survey was actually made, such unmarked lines will prevail over courses and distances, in case of a conflict.—*Maddox vs. Turner* (*Tex.*) *15 S. W. 237.*

72. Where adjoining land-owners have settled the boundary line between their respective tracts with full knowledge as to the true boundary, and have both occupied up to the line as established for more than 21 years, they are estopped from disputing the accuracy of the line as established.—*Sheetz vs. Sweeney* (*Ill.*) *26 N. E. 648.*

73. Allegations that the true location of a certain lot was not well defined and known, and that various surveys had left it uncertain, are sufficient to sustain an agreement fixing the boundary line.—*Harne vs. Smith* (*Tex.*) *15 S. W. 240.*

74. Such an agreement is valid and binding on the parties and their vendees, though they were both mistaken as to the true location of the line.—*Harne vs. Smith* (*Tex.*) *15 S. W. 240.*

75. The description in a deed began: "The south half and the east half of the northeast quarter of section nine," described several subdivisions and concluded: "Containing, in all, 510 acres." If the first clause was interpreted to mean the south half of the northeast quarter and the east half thereof, the effect would be to duplicate the description of one "forty," while to construe it as meaning the south half of section nine and the east half of the northeast quarter thereof would avoid any duplication, and conform the description to call for quantity. *Held* that, under the rule that the call for quantity may be resorted to to make that certain which would otherwise be

uncertain, the latter interpretation should be adopted.—*Davis vs. Hess (Mo.) 15 S. W. 324.*

76. The description in a deed was, "a certain tract or parcel of land begins at a pine on R. line, thence running K. S. line, thence binding on L. S. line, thence running the T. L. line, then to the first station, including twenty-five acres, be the same more or less." *Held*, that the description is not void for uncertainty, since the boundaries pointed out may be established by extrinsic evidence.—*Allen vs. Sallinger (N. C.) 12 S. E. 896.*

77. Where land is known both as the "Geo. P. Digg's Survey" and the "J. P. Digg's Survey," and there is but one Digg's survey in the county, the variance in a deed between "Geo. P." and "J. P." does not amount to a misdescription.—*Burchard vs. Record (Tex. Sup.) 17 S. W. 241.*

78. When an authenticated plat of land is referred to in a deed conveying a portion of the tract, it becomes as much a portion of the deed as if fully incorporated in it.—*Whitehead vs. Ragan (Mo. Sup.) 17 S. W. 307.*

79. Where a deed conveys lots according to a certain plat, the fact that the plat is invalid does not affect the deed.—*Young vs. Cosgrove (Iowa) 49 N. W. 1040.*

80. A land owner having sold 22.29 acres of the southeasterly portion of a certain quarter section, conveyed to another person "the east one hundred acres [of the quarter section] commencing on the west bank of the F. river, and running back to the westward far enough so as to contain one hundred acres, and so as to comprise the east one hundred acres [of the quarter section] excepting therefrom a small piece of land" previously sold. *Held*, that the deed conveyed 77.71 acres. McKee, J., dissenting.—*Cox vs. Hayes, 27 P. 785, 64 Cal. 32.*

81. A deed conveying lots 1, 2, 3, and 4, in a block, they being all the numbered lots in the block, does not pass title to any part of a strip of land included in said block, but not numbered as a lot.—*Young vs. Cosgrove (Iowa) 49 N. W. 1040.*

82. Plaintiff purchased a lot fronting on the south side of a street in a village from a corporation owning the street, and the lands on either side thereof. Defendant dug a ditch in front

of defendant's lot, between the sidewalk and the middle of the street, of such depth that it cut off the veins of water supplying plaintiff's well in front of this lot. *Held*, in an action to recover damages for defendant's alleged trespass in digging the ditch that the question whether or not the plaintiff's lot extended to the middle of the street was one dependent upon the interest of the parties to plaintiff's deed; and that, plaintiff's deed having described his lot as beginning at a point on the southerly line of the street and running thence along the south line of that street to a certain point, the intent of the grantor was to exclude any portion of the street from the grant.—*Dexter vs. Riverside & Oswego Mills 15 N. Y. S. 374.*

83. A deed to premises bounded on one side by Long Island sound, which described one of the boundary lines as running north to a point on the sound, and "thence running along said shore and sound as the same bend and turn easterly, and thence southerly," to another intersecting boundary line, conveys the space on the shore of the sound between high and low-water mark, and the purchaser who bought by the acre is not entitled to have the purchase price per acre of the premises abated to the extent of that space, as for a deficiency in the acreage. Affirming *14 N. Y. S. 294—Oakes vs. DeLancey 15 N. Y. S. 561.*

84. Where a deed describes the land by metes and bounds, and then gives a general description of it as being "all of the * * * survey, except 140 acres belonging to" a certain estate, the particular description must control, and only the land contained within the described metes and bounds passes.—*Cullers vs. Platt (Tex.) 16 S. W. 1003.*

85. A deed of land, describing it by boundaries, and as containing a designated quantity, is not a conveyance within fixed limits, so as to give the donee title to land in excess of the quantity named, where one of the boundaries is given as the donor's own land, and no limit is fixed as to where such boundary is to commence.—*Derouen vs. Davidson (La.) 10 So. 7.*

86. A grantor conveyed "lot 1, block 2, town of Concho, M's addition to San Angelo, said lot being 60 feet front by 120 feet deep." Afterwards he conveyed to the same grantee "lot 2, block 2," "said lot being 60 feet front by 120 feet deep." The grantor owned the whole block at the time of these conveyances.

The addition had been laid out by him, and the plat on file in the county clerk's office divided block 2 into lots 26 feet wide by 120 feet deep. *Held*, that in the absence of evidence indicating a contrary intention, the word describing the width of the lots must be rejected as *falsa demonstratio.—Arambula vs. Sullivan* (*Tex.*) *16 S. W. 436.*

87. A deed conveying a portion of a block of land described the boundaries as "beginning with the southeast corner of the block; thence west with the south boundary line of said block —— varas, to a stake;" and then gave the remaining boundaries by courses and distance, "so as to contain five acres of land off the east side of the block." *Held*, that the deed limited the quantity of land intended to be conveyed to five acres, and that the length of the first line called for in the deed was not specified because it was intended for that line to be only long enough, when considered with the other calls in the deed, to make an area of five acres.—*Henry vs. Whitaker* (*Tex. Sup.*) *17 S. W. 509.*

88. S. and G., owning a lot in common, divided it between them, and their portions, by mesne conveyances, became vested in plaintiff and defendant, respectively, through an intermediate grantee of both portions. The deed of S.'s portion down to plaintiff described the tract as containing 93 acres, more or less, and the deeds from G. down to defendant described his portion as containing 100 acres, more or less. The land in dispute was a tract midway of the lot which each claimed to be included in his portion. *Held*, that if plaintiff first purchased from such grantee with reference to a boundary established by S. and G., he would be entitled to take up to that boundary only, whether the tract so determined contained the number of acres called for by his deed or not; but, if he purchased by an imaginary boundary, he would be entitled to 93 acres, though it might leave defendant, who purchased after him, less than the number of acres called for by his deed.—*Adams vs. Powell* (*Ga.*) *13 S. E. 280.*

89. S. and G., owning a lot in common, divided it between them, and their portions, by mesne conveyances, became vested in plaintiff and defendant, respectively, through an intermediate grantee of both portions. The deeds of S.'s portion down

to plaintiff described the tract as containing 93 acres, more or less, and the deeds from G. down to defendant described his portion as containing 100 acres, more or less. The land in dispute was a tract midway of the lot which each claimed to be included in his portion. The evidence tended to show that a boundary line had been established between S. and G., which was recognized by subsequent purchasers. *Held*, that it was error to charge that, if defendant had 100 acres without taking in the tract in dispute, and plaintiff did not have 93 acres without including it, plaintiff should recover the tract; since if S. and G. had established a boundary line, and defendant had purchased his tract with reference to it, he would be entitled to hold it, though it contained more than 100 acres.—*Adams vs. Powell (Ga.) 13 S. E. 280.*

90. In an action of trespass defendant railroad company put in evidence a location, the validity of which was not disputed, of land which was described as adjoining the land of plaintiff's predecessor in title. Defendant, after filing the location, accepted a deed from plaintiff's predecessor, describing the land conveyed as the land taken by the location, which description did not include the land in dispute; but at the date of the location defendant did not admit, nor did plaintiff's predecessor claim, that the latter had title to the premises. It also appeared that plaintiff's predecessor gave defendant a license to use land, which license would have been useless unless defendant owned the land in question. *Held*, that defendant was not estopped to claim that the land in question was covered by the location.—*Cunningham vs. Boston & A. R. Co. (Mass.) 27 N. E. 660.*

91. The owner of a survey conveyed a certain amount from the east side of the tract, the west line being marked on the ground where defendant claims, and the land was subsequently deeded to M. Plaintiff acquired title to the west side of the tract, and caused a survey to be made, the east line of which was run and marked on the ground 18 rods east of M.'s west line, thus including the strip of M.'s land which is in dispute, and the survey was returned to the land department, and a patent issued. Neither the survey nor the patent called for any marked line, but merely called for M.'s land as adjoining on the east. M. also caused a survey of his tract by the same

surveyor, and received a patent, but neither the survey nor the patent referred to the line established in plaintiff's survey, but merely called for plaintiff's land as adjoining on the west. M.'s land was, after mesne conveyances, deeded to defendant by deed describing the land as the same previously conveyed to M. There was no evidence that M. agreed to the line as established by plaintiff's survey, nor that M.'s survey and patent adopted it. *Held*, that defendant was in privity with M., and has title to the tract according to the line as established before plaintiff's survey.—*Waters vs. Starr (Pa.) 21 A. 865.*

92. Defendant and plaintiff's predecessor in title took a conveyance of the north half of certain lots, the south half of which had been conveyed to one R. There was a fence supposed to be R.'s north boundary. On partition the south 58¼ feet of the land was measured north from the fence and conveyed to plaintiff's predecessor, a notch being cut to show the division line. It was afterwards found that R.'s true boundary was 3.3 feet north of the fence, and plaintiff sued to recover a strip of that width north of the division line as fixed by the notch. The deed of partition and subsequent deeds of plaintiff's lot called for R.'s land, and not the fence, as its southern boundary, and described the lot as 58¼ feet wide. *Held*, that testimony was not admissible to affect or vary the boundaries as fixed by the deed, and that the location of the division line in partition was not binding, if by mutual mistake the parties took R.'s fence as the true north boundary of his lands.—*Davis vs. Russell (Pa.) 21 A. 870.*

93. Where the original survey and field-notes of a township show all the sections full, but, after all the natural monuments in the two northern tiers of sections have been lost, it appears that there is a shortage somewhere within those two tiers, such shortage will be apportioned between the two tiers, and not imposed wholly on the northern tier, though the survey was made by beginning at the southeast corner of the township, and working north.—*James vs. Drew (Miss.) 9 So. 293.*

94. On a question of boundary between adjoining lands, evidence is admissible that a former owner of part of the land on one side of the disputed line, since deceased, while upon the land, negotiating a sale of it, pointed out the location of the line and the landmarks upon it; it not appearing that he

had any interest to locate the line differently from its true position.—*Royal vs. Chandler (Me.) 21 A. 842.*

95. Upon conflicting evidence as to whether acts and declarations of a former owner of land, offered as proof of the boundary thereof, were made before or after he conveyed the land, the question is to be determined by the judge, in his discretion.—*Royal vs. Chandler (Me.) 21 A. 842.*

96. In 1844 a land owner granted lands, bounding them on the south by the center of the "state road," and on the east by a north and south line far enough east to include 40 acres. Subsequently he granted other lands on the east of this tract. On a question as to the location of the common boundary, it appeared that in 1844 there existed a recorded plat of a state road, but the road existing at the time of the trial did not correspond therewith. On the evidence it was doubtful whether any state road had been opened in 1844. *Held*, that the plat was properly admitted, since, if no road was open, the description must refer to it.—*Atwood vs. Canrike (Mich.) 48 N. W. 950.*

97. In an action involving the location of the dividing line between the lands of plaintiff and one M. it appeared that a continuous straight line formed the north boundary of both tracts and the south boundary of the land of one E. E. testified that he had divided the division fence with plaintiff and M., and that for 50 years he had begun at a white oak, which plaintiff claimed as his northeast corner, and built the east half of the fence between the land of himself and plaintiff, and the west half of the fence between the land of himself and M. On cross-examination it appeared E. built half of the fence between his land and that of plaintiff and M., and that the part so built by him was on both sides of the oak, but that neither party had ever spoken of the oak as the point of division. *Held*, that the testimony of E. should have been stricken out on defendants' motion.—*Ostrander vs. Washburn, 14 N. Y. S. 584.*

98. On a question whether defendants had maintained adverse possession for 15 years up to a certain fence, it was error to admit evidence that it was commonly understood in the neighborhood that the fence was not on the true line.—*Atwood vs. Canrike (Mich.) 48 N. W. 950.*

HON. GEO. E. STEELE.

BY FRANK HAMILTON, OF TRAVERSE CITY.

Geo. E. Steele, of Traverse City, Michigan, was born October 23, 1842, in Andover, Ashtabula county, Ohio. His ancestors on his father's side he follows back nine generations to the year 1631, where in Hartford, Connecticut, further traces are lost. On his mother's side the family history shows a clear genealogical line to an equally early date. The farm whereon he was born, was one selected by his grandfather in 1806 from the wilderness of the Western Reserve. Here, in 1809, Geo. E. Steele's father was born; and in 1845, when he was three years old, his father moved to Kingsville, Ohio, and lived there sixteen years. George's first day in school was spent in what had been a blacksmith's shop in that village, but soon the town and school outgrew the old shop and there for a long time a noted and most successful high school sustained the center of educational influence for the surrounding country, and there he found most of his schooling; interspersing the exercises and vacations with labors of a different kind, using the saw, plane and hammer, as well as the ax, hoe and rake. His familiarity with these articles when younger has never lessened his interest in them, nor in the class of men who have cleared the forests and made honest toil productive.

In the spring of 1861, his father moved from Ohio to Benzonia, Michigan, where the pioneer life was again entered upon with new zeal. The clearing of forests in northern Michigan was no small task and this departure of his father's furnished no opportunities for further home school education; it furnished to George E., however, unbounded facilities for the development of pluck, muscle, energy and the like, and no small share of these qualities are still retained by him. Along with these grew sterling character, mostly ambition and a desire to know more and to be more than the forest life afforded. The building of the log house, the church, the schoolhouse, and the laying out of roads served a good end later on in life.

In 1864 he entered the State Agricultural College, at Lan-

sing, he being the first student to enter from north of Grand Rapids; walking thirty-two miles to Manistee, having his trunk tied onto the mail cart; he took a schooner to Milwaukee, a steamer back to Grand Haven, four days in making the trip, which was considered good time. On his return to the north he married Miss Lois S. Judson, daughter of S. F. Judson, of Medina county, Ohio, and then again commenced in the woods to make a farm. But his recent studies in Lansing had fitted him for other work and the frequent calls to make surveys of lands, to locate government and state lands, and make timber estimates, deprived the farm of a farmer and he soon removed to Elk Rapids, Antrim county, where he gave his entire time to matters pertaining to real estate. In 1882 Traverse City became his next and last place of residence, here forming a partnership with the late C. O. Titus, in real estate, insurance and abstract business. The firm was dissolved three years later by the death of Mr. Titus. Since that time he has been called upon to serve in many capacities for which he is fitted and which no one but Geo. E. Steele could fill. No man in this country has a better knowledge of the products and the location of good "sections" than he, no one is more sought for to correct the lines of county, town or village than he; the best railroad route he knows and the information given by him on these lines has helped many a poor fellow "out of the woods." While he has never sought public honors he has been chosen to fill many offices, all of which he has proved himself eminently fitted to fill. In 1876, while residing in Elk Rapids, he was selected representative by the republican party of Antrim and Charlevoix counties, serving his full term of two years meritoriously. Soon after his coming to Traverse City he was elected a member of the school board and served as moderator from 1885 to 1888. He has also been village trustee, and in both capacities proved a most active and useful officer. He was two years president of the Traverse City Business Men's Association, and has all along been county and village surveyor. His connection with the civil engineers of Michigan dates from the beginning of their organization; he was one of the charter members of the Michigan Association of Surveyors and Civil Engineers, and vice president from their organization

to 1885. He was elected vice president of the Michigan Engineering Society in 1886, acting president in 1887, and elected to that office for the years 1888 and 1889.

In manner Mr. Steele is genial and witty, possessing marked individuality, a capital host, a sought-for guest, an encyclopedia of general informantion, a ready public speaker, and fluent writer. Conservative in all his ways of dealing, he is remarkable for his accuracy and precision. His associations with men inspire confidence in his ability and integrity. Always a member of the Presbyterian or Congregational associations and identified with many charitable and educational organizations, he is most essentially a self made man, endeavoring always to serve noble and unselfish ends. His name is at the head of the list among the active and public men of northern Michigan.

DEPARTMENT OF MATHEMATICS AND CIVIL ENGINEERING.

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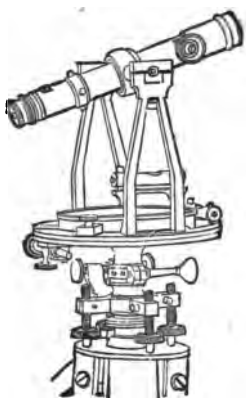

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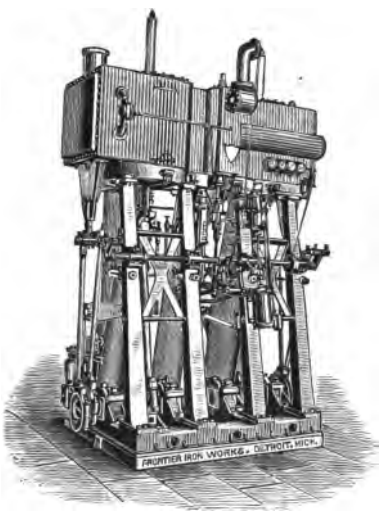

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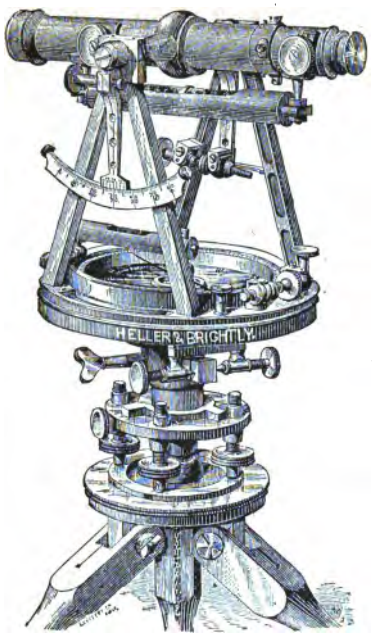

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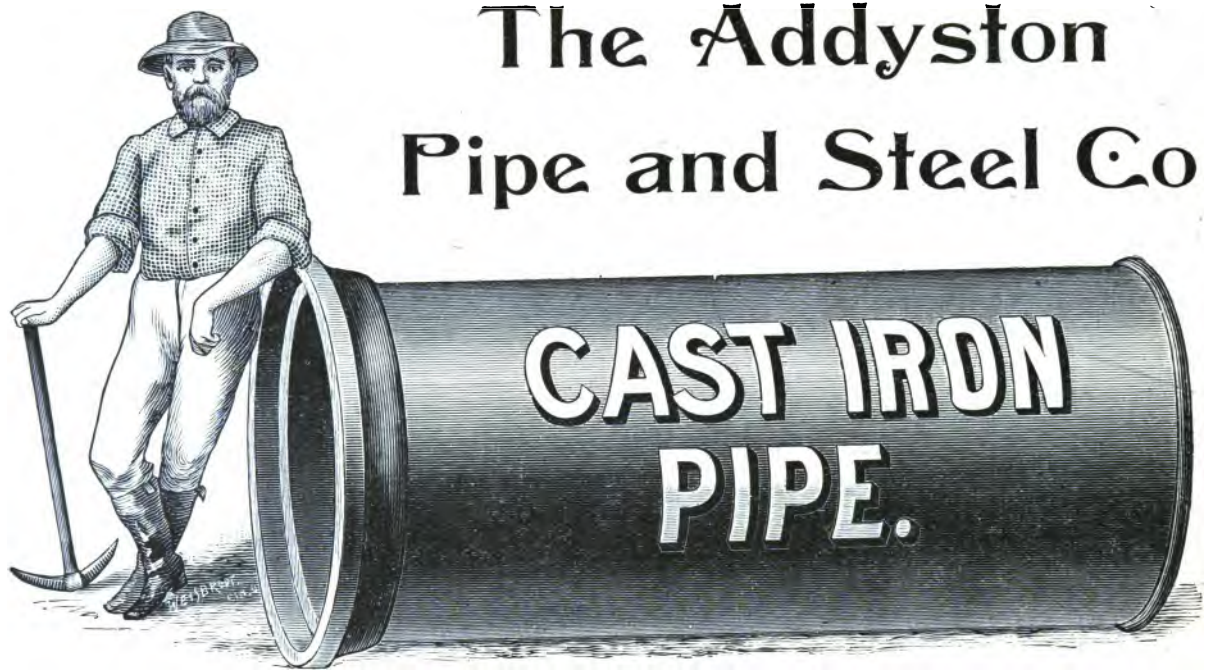

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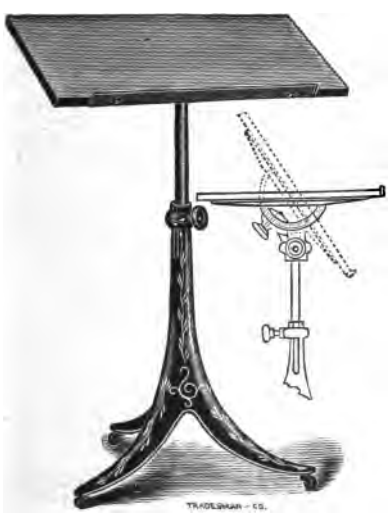

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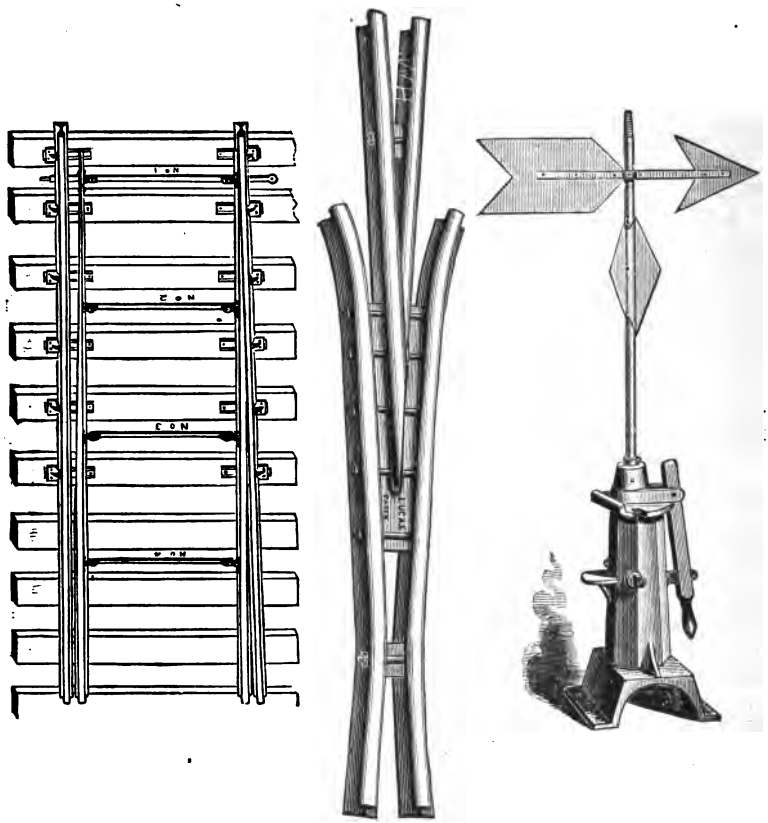

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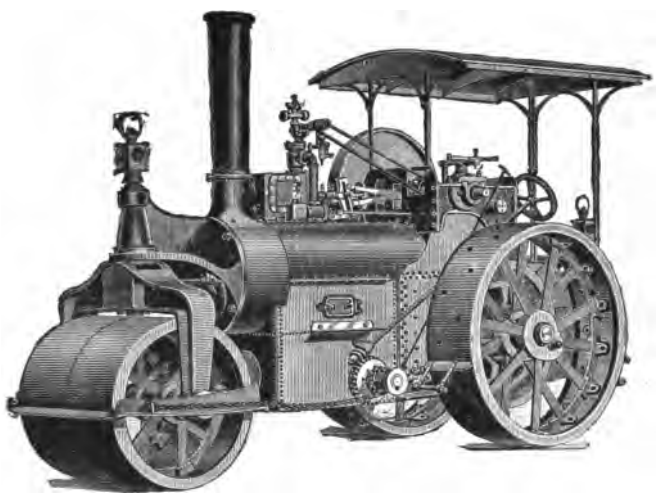

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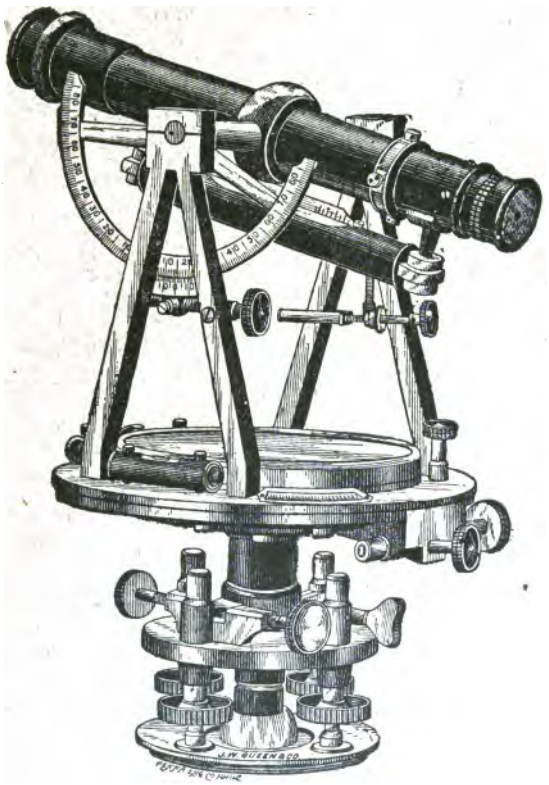

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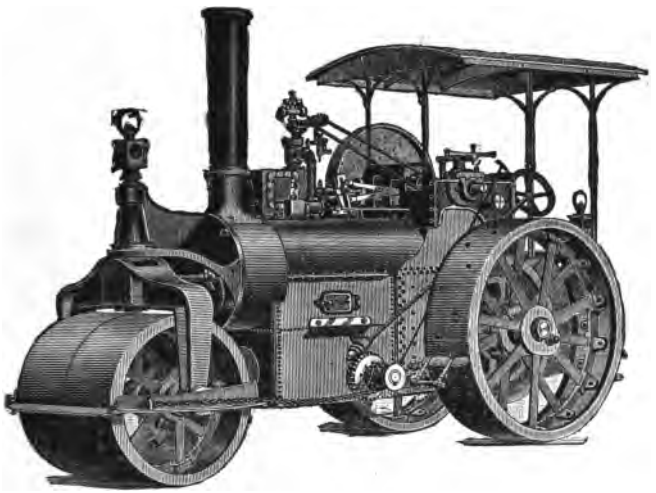

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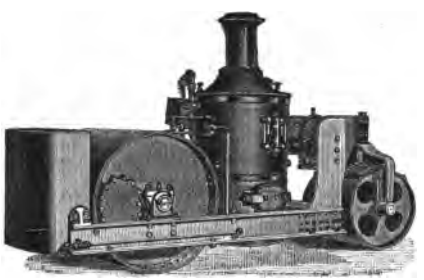

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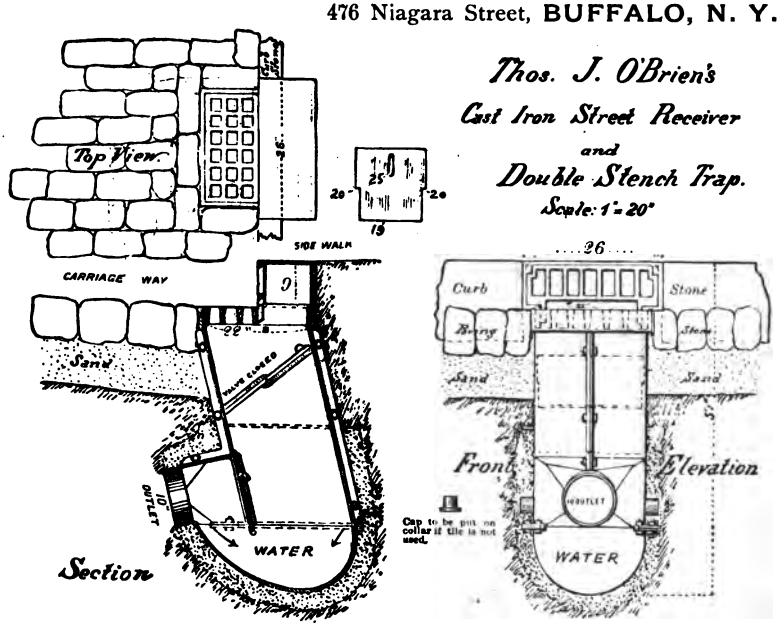

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Very Truly Yours
John W. Foster

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ANNUAL CONVENTION, 1893.

AUTOBIOGRAPHICAL SKETCH OF JOHN H. FORSTER.

To Frank Hodgman, C. E., Secretary Michigan Engineering Society.

DEAR SIR:

While I am proud of the interest which you take in me as a comrade, I am free to confess that it is with great reluctance that I undertake to comply with your request, urgently made, to hand you some "field notes," in relation to my life-work as a civil engineer and surveyor. There has been nothing "brilliant" in my career, and all I can say for myself is, that I have always endeavored to discharge my duty honestly and faithfully, under trying as well as pleasant circumstances. The fraternal feeling existing among engineers, emboldens me to write.

Born early in this century, I feel that I have lived in an active, formative period and, not only so, but in the golden age of the republic; simple living, high endeavor, pioneer zeal, have characterized this nineteenth century. Battles for freedom have been fought and won, and civilization has advanced with gigantic strides. Civil engineers and surveyors have done their full share in this work. Their coadjutors, the mechanical engineers, are following close behind—perhaps to take the lead in future. The engineer has explored the continent and laid steel rails across waste places; surveyed vast domains in the face of hostile tribes, and marked out the homes of crowding

settlers; has opened lakes and rivers, far and near, to navigation, and has rendered available the treasures of the mines.

The engineer who has practiced his profession for forty or fifty years, has witnessed a progressiveness, an elevation, an exaltation in that profession, truly marvelous. He can point proudly to engineering achievements that would have astonished his forefathers. The marks of his genius are seen everywhere, between the Atlantic and Pacific; he has battered down the walls of exclusivness, and invaded Japan and China.

I was born at Erie, Pennsylvania, on the 24th day of May, 1822. My grandfather, Thomas Forster, was commissioned a Colonel by Washington, came from Harrisburg to Erie at the head of a colony of settlers, late in the last century. He surveyed and mapped the borough of Erie and owned a large portion of it. My maternal grandfather, Judge William Ball, was a large land holder and prominent citizen. He was a Scotchman. Colonel Thomas Forster's father came from Belfast, Ireland. His wife was a Montgomery. Judge Ball's wife was his sister. Thus the writer of this was of a Scotch-Irish descent. His father and mother were cousins. In the war of 1812, grandfather Forster was Colonel of Militia; he was foremost citizen in Erie and entertained Commodore Perry and other officers of the army and navy. Several of his daughters married officers who, afterwards, became distinguished in history. I write with pride, that both of my grandfathers had wives who loved their lords, each of whom bore fourteen children.

My father, Thomas Forster, first a merchant in Erie, later on became an engineer, and spent a large portion of his life in river and harbor improvements, under the United States Government.

The writer of this paper was educated at the Fredonia Academy and Livingston county high school, New York. Began engineering work as rodman, on the New York and Erie Railroad, in Cattaraugus county. After a time the company failed and the engineering department was disbanded, minus a whole season's pay. First unfortunate venture! For a time engineering enterprises were dormant. The writer,

having nothing better to do, to win bread, tried his hand at teaching a select school and reading Blackstone evenings, in the dull hamlet of Dunkirk, N. Y.

In 1843, catching the prevailing western fever, he migrates, thus anticipating Greeley's advice. Greeley was then a poor printer, and spent some of his time on the hills of Chautauqua. He sailed in a schooner from Dunkirk to Chicago, getting his first impression of the great chain of lakes, whose coast lines he was destined in the future to help survey. Landed after a two week's voyage in the village of Chicago, he encamped at night on the open prairie, in the tall grass, just across the river from the present Tremont House, then a two story white tavern, with the Conch brothers as landlords. Tried his unskilled hand at farming on the bank of Fox river, near Aurora; one year sufficed—on the farm. Returned to Dunkirk, N. Y., broken down financially and physically. The pestilential ague froze the marrow of his bones.

In 1844 the writer joined the lake survey as civil assistant. Our party, under the immediate command of Lieut. Gunnison of the corps of topographical engineers, spent most of the summer in measuring a base line for main triangulation on the north shore of the Straits of Mackinaw, a wilderness teeming with mosquitoes, black flies and *brulots*. It was near the present Mackinaw City. Late in the Fall ran the shore line to Presque Isle. Went into winter quarters at Buffalo. I will note here, that Lieut. Gunnison, a brilliant young officer, some years later, made a survey of Great Salt Lake, Utah, and published a book about the Mormons. Still later, while engaged in running an experimental line of railway from the Mississippi Valley to the Pacific, was massacred with his party by Mormons, disguised as Indians, near Sevier river, Utah. His book was doubtless the cause of his melancholy death. He was a dear friend of mine; it was by mere chance that I was not killed with him.

In 1845 the surveying parties began the survey of Green Bay, Wis. That section was almost an unbroken wilderness, in possession of Indians. Near the mouth of Fox river there was the little town of Astor and Fort Howard. There was a saw mill on the Menominee river. We did a large amount of

work. But before the close of the season the appropriation failed and the parties were disbanded forthwith. The writer made his way in a lumber wagon to the new town of Milwaukee, where he embarked on a steamer, and in due time arrived at Dunkirk.

Went to teaching and reading law once more.

In 1846 he was aroused from his quiet pursuits in the drowsy lake village by rumors of great discoveries of copper in the Lake Superior country, far off in the northwest. Lured by the prospect of great gain, and more by the certainty of an active life, the writer went to Detroit and joined an exploring party as a surveyor. In due time his party reached far-off Copper Harbor and Ft. Wilkins. He sailed across Lake Superior in a small schooner named the Swallow, lodging in the main hold, on pork barrels. He footed it across the portage at the Sault, where one now may see the great ship canal, with the largest locks in the world. He spent nearly two years in that land of frost and snow, working vigilantly as a surveyor, explorer, geologist and mine manager. He learnt much about woodcraft, the sweet uses of adversity, self reliance, and the value of a sufficiency of food and raiment. It was a hard life of toil, exposure and unmitigated hardship. Hours were long. As for fortune, the fickle jade ever eluded our grasp. In 1847 the copper speculation suffered a collapse. Everyone hastened to get out of the accursed country. The writer gladly retired with the rest.

In 1848 rejoined the Lake Survey, under my old commander, Gunnison, engaged on the survey of lake Erie, from mouth of Detroit river to Maumee bay. Happy again in this congenial work!

In 1849 I resigned from the lake survey, having obtained the appointment of first assistant engineer on the survey of the Mexican boundary line. I could not resist the spirit of adventure that lured me on to far distant, unknown lands. Our objective point was San Diego, California. The boundary commission rendezvoused at New Orleans. It sailed thence in a U. S. transport for Chagres, Isthmus of Panama. Arrived at Chagres after a delightful voyage across the Gulf of Mexico

and Caribbean sea, the large party of surveyors was divided and sent up the river in small dug-out canoes to Gorgona. The writer spent several days in a canoe, propelled by two fellows, nude men, with bamboo poles, subsisting upon the country. He could not speak a word of Spanish, nor could anybody he saw understand English. So he got along with "natural signs" very well. Crossed the mountains on foot, suffering terribly from heat; clothing was not necessary as it had been on Lake Superior!

We lay at Panama two months, our lives endangered by fever and cholera—waiting for transportation. By this time the gold discoveries in California were an assured fact, and the Isthmus and City of Panama were crowded with eager, dispairing adventurers, seeking passage up the Pacific to the golden shores, El Dorado. In the month of May, we embarked at Panama, arriving at San Diego early in June. We were six months *en route.*

Landing on Point Loma, the writer spent his first night in one of those famous "hide houses," mentioned by Dana. The 22000 stored hides impress one with their pungent odor and fleas. The next day we entered the adobe built, uninteresting pueblo of San Diego, so long the object of our search. The surrounding hills covered with grass, upon which great long-horned cattle grazed, and the noble bay of San Diego relieved the scene from utter flatness.

After some weeks waiting, the Mexican commission arrived. The officers of this commission were highly educated gentlemen; the rank and file, a mob of *greasers*, many of them taken from prison to serve as soldiers. There were plenty of women in the train.

Fifteen miles above San Diego, or the head of the Bay, our engineers encamped. The writer's first duty was to measure with his party, a marine league south of the southernmost point of the Bay as per treaty stipulation. The south end of the Marine league was to be the initial point of the boundary line, on the shore of the Pacific. This marine league was measured with much care, with a French metre bar and the writer had the pleasure of driving the stake at the point, on a

bold bluff, at whose base the Pacific ocean is forever rolling up its restless billows.

During the summer the writer assisted in making a topographical survey of San Diego Bay. He found drinking water scarce, but rattlesnakes too numerous. Curlews and quail were abundant.

In the month of October, 1849, he accompanied Col. Gray's party (Gray was surveyor under the Treaty,) across the coast mountains and interior desert to the Colorado and Gila rivers. We followed the assumed line of the Boundary, making a rough survey as we advanced. No white man had ever explored the route. Suffering and hardships were concomitant of the journey. In the great desert, north of the Gulf of California, we nearly perished from thirst. Our poor mules suffered terribly; there were earthquakes, and the heat on those sandy bottoms was terrific. The cool delicious waters of Lake Superior constantly returned to my memory with feverish longing. With swollen tongue and bleeding lips the cry for water was inarticulate, but very real. In the heat of the desert, Col. Gray left me to proceed alone with a small party, he returning to the Pacific with a starving party of U. S. officials—"carpet bag" custom house. I traveled night and day—the stars were my guide over the shifting sands. The Colorado Indians were hostile, but we reached the mouth of the Gila without loss of scalps. A troop of U. S. dragoons was stationed there, and Lieut. Whipple, corps topographical engineers, had an astronomical camp. *He* fed me; after which I threw myself on the ground and slept fourteen hours without turning over. I made a survey of the junction of the Gila with Colorado, by triangulation; there were no boats, so Dr. Perry, of the army, and botanist, volunteered to set up my flags at the mouth of the Gila. He swam the wide, swift-flowing, yellow Colorado, set up the flags, and returned safely. At this time the thermometer stood 110° in the shade, and a bath was agreeable. Finishing the survey at 10 p. m., we mounted our mules and set out for the Pacific. Passed hundreds of emigrants, pushing forward through the sands, for the distant gold fields. Suffering, destitution, ruin and death marked the long

line of our route. We, ourselves, suffered greatly from want of food and water. But, finally we reached San Diego without loss of man or beast, but ragged as savages and as ravenous.

The commission spent the winter, "rainy season," in the mud hovels of San Diego, subsisting upon hard-tack, coffee and "coone," bull meat. The commissioner deserted us and went to Monterey and was elected U. S. Senator. Col. Fremont, the new commissioner, under Gen. Taylor's administration, we never saw. He too, had the Senatorial bee in his bonnet. The outcome of the whole matter was this: Abandoned by superior officers, without food or pay, the subordinates left to themselves, scattered far and wide.

The writer, having no choice, went to Alta, California, and remained in that section until 1855. He by turns was a day laborer, a farmer, a cow-boy, a swine-herder, a gold miner, a postmaster, a tramp, a Probate Judge, (Public Administrator,) a Judge of County Sessions and escaped being State Senator by coming back to the "States." His patrons and friends, most of them, having been shot in rows, and liking a whole skin better than a possibly eternal resting place in the land of the setting sun, the writer "vamosed."

In May, 1855, by a rapid transition, the writer rejoined the Lake Survey at Detroit. He came home via the Nicaragua route, over lines near the proposed Nicaragua canal. A canal at that point of the Isthmus, seemed to be of no difficult attainment.

The Lake Survey was now under the command of Capt. Meade, afterwards General Meade. The month of June found me with Mr. Wm. H. Hearding, C. E., making a topographical survey of Beaver Island, lake Michigan, under the hostile eye of King Strang and his Mormon disciples. Strang was a man of strong character and considerable ability. Later on he was shot by one of his own people.

1857 I quitted the Lake Survey for the River and Harbor Improvement department—a promotion. Capt. Whipple, U. S. Eng. was chief officer. I had known him as astronomer of the Mexican Boundary Line survey. I was placed in charge of improvements in St. Mary's river, with Capt. Whipple, later

on a general in the Union army, killed by a sharp-shooter at Chancellorville. He had offered me the position of assistant adjutant General in his division, which was declined. He was a dear friend.

I remained two years on St. Mary's river, first completing a canal by dredging through the flats of Lake George, and dredging west channel of Neebish rapids, when I resigned from the Government service, *finally*, to take charge of private work at Portage lake, lake Superior, another promotion! Built a breakwater at mouth of Portage river, during the winter of 1859, cutting holes in the ice to sink cribs in. In the fall of 1858, dredged a channel 1200 feet long, through a tamarack swamp, into the river, and made a topographical and hydrographic survey of the river, a crooked stream five miles long. The season being late, I could only lay out the work and finish soundings before the ice closed the river. After the ice became solid, and the marshes lining the river frozen, I managed to do all instrumental and sketching work admirably. Winter is the time to *do* marshes. But handling my theodolite with the thermometer 10° to 20° below zero was rather *hot* work. Without gloves, the brass screws would *glue* ones fingers instanter. Altogether it was nipping, lively work, but very satisfactory at the end. A large map of the river was made at my leisure, in my parlor at Houghton, my wife and baby being my company. Strange! I had forgotten to tell you of the most important event in my life, so far as I am personally concerned; the happiest event; and the luckiest. Namely, on October 22, 1855, I was married to Miss Martha Mullett, youngest daughter of John Mullett, the distinguished land surveyor and engineer of Detroit. You see, as I am a surveyor, I am fortified on all sides, for, you will notice that my grandfather and father were of the same ilk.

In the fall of 1860, I was appointed chief manager (agent) of the Pewabic and Franklin mines, (copper,) still acting as engineer of the Portage River Improvement Company, and also as director in that company, for several years thereafter. Portage river was opened by the mining company of Portage lake, without assistance from the general government. I

piloted the first steam boat up to the mines. In the course of five years, I finished mine-plants, mills, docks, roads, and tram-roads, for the Pewabic and Franklin mines, and brought both of those mines to a dividend paying basis.

In 1864, the writer was elected to the State Senate—the only Senator from that vast territory, known as the Upper Peninsula. Political office not suiting the habits and tastes of an old surveyor, subsequent honor of the kind, though tendered, was respectfully declined.

Overwork and affliction—the loss of my sweet daughter, and only child, compelled me to resign from the charge of the mines.

My wife and I spent a long vacation in traveling.

But idleness did not bring *peace*. In 1866, I accepted the management of some copper mines, upon which work had been suspended for some time. Built a stamp mill, docks, etc. But the mines were not profitable.

In 1868, I visited southern Nevada, to examine and report upon certain silver mines. I spent the winter in the mountains, suffering much from cold and fearing the Indians, then on the war-path on several lines. Reached San Francisco with a whole scalp in March. Returned to New York by steamer, via the Isthmus of Panama, sweltering under tropical heat. About the middle of May, the steamer I was on, a lake-craft, was stuck fast in the ice, off Marquette, Mich.

Governor H. P. Baldwin, intercepted me in Detroit, and commissioned me as engineer of the State work, namely, "The Portage Lake and Lake Superior Ship Canal." Remained in charge of that work during a period of five years or more, serving part of the time under Gov. J. J. Bagley, seeing its completion. This canal cost about $3.000,000. In the year 1874, much broken in health, the result doubtless of early privations, and with a crushed leg, so imperfectly mended as to render tramping and standing by a transit a grievous labor, the writer, unwillingly, but gracefully as possible, retired to his farm, near Lansing, in Ingham county, Michigan.

The graceful part came from the fact, that he could retire with comfort. Wonderful to relate; for one of his profession,

after so many buffetings of fortune, he had accumulated enough of the "dust," as we used to say in the gold mines some forty years ago, to keep the wolf from the door during a reasonable term of life. On Springbrook farm, surrounded by his gentle Jersey's, his fleecy Shropshires, his pigs and chickens, he is reasonably happy, thank you, "the world forgetting, and by the world forgot."

But like an old man who has passed the mile stone marked 70 years, in his quiet retreat he "delights to fight his battles over again."

In his ample library, he can commune at will with the good and wise of all times, but his heart often yearns for his old comrades who have cast off the veil of the flesh, and are hidden from his mortal eyes.

The writer must fain confess, that the path set for him to travel through the wilderness of life, has not been free from danger and privations of an uncommon kind.

So it is with unfeigned gratitude, that he acknowledges the goodness of his Heavenly Father in rescuing him from so many perils, and he looks to a merciful Savior for ultimate pardon and peace.

"So long Thy power has blest me,
Sure it still will lead me on
O'er moor and fen, o'er crag and torrent,
Till the night is gone,
And with the morn those angel faces smile,
Which I have loved long since, and lost awhile."

—From Lead Kindly Light, No. 512, Church Hymnal.

Very sincerely your friend,

JOHN HARRIS FORSTER.

November, A. D. 1892.

PAPERS AND DISCUSSIONS,

At the annual convention, held in the council rooms at the city of Lansing, Jan. 17, 18 and 19, 1893.

ADDRESS OF PRESIDENT MUENSCHER.

Gentlemen of the Michigan Engineering Society:

In compliance with the custom which requires your president when entering upon the discharge of his duties, to say something bearing upon the interests of this society, I beg leave to touch briefly upon a single point. It is the duty which the members of the society owe it in the way of contributions to its proceedings. I am aware that this subject has been alluded to before, and more than once, but it has been only within the last few weeks that I have begun to appreciate the labors and disappointments which have been the lot of our worthy Secretary for so many years, for I never knew till then how negligent most of us have been.

Let me call your attention to a few facts. Our last Annual showed a membership of 152. Of these but fifty, or less than one-third of the members had, as far as I can learn, ever contributed a written paper to our proceedings. Two others have contributed valuable oral discussions. The remaining 100, or *two-thirds of the entire number have never contributed a single line,* except perhaps to ask an occasional question. Of the fifty who have contributed at all, twenty-six, or more than one-half, have furnished but one paper each. Ten of the remainder have furnished but two papers each, leaving but fourteen, or one eleventh of the membership to furnish more than one-half of the entire proceedings of the society, and out of these fourteen, it is an actual fact that only three gentlemen have furnished more than twenty per cent. of the entire amount.

The mere statement of these facts ought to make some of us pause and reflect whether we have done our duty to a society which gives us so much in return for the trifling fees

which we pay, or rather whether it has not been ungenerous for us to be content to enjoy the benefit of other men's labors, while neglecting to contribute anything ourselves to the common fund.

Much of this neglect is due, no doubt, to want of leisure, but more, I am inclined to think, to the fear that we think we cannot say anything that is new; that what is interesting to us is probably perfectly familiar to all the rest of the society, and that if we write about it, they will look upon our effort as threshing out old straw, or cracking old chestnuts. Just here is where we are liable to make a great mistake. If all of us should wait until we could announce some startling discovery, or develope some new principle, there would be but few papers written. It is only once in an age that a Newton, a Laplace or a Franklin flashes upon the world to discover some great law of nature, or found a new science, but in the meantime thousands of humbler workers, like the minute builders of the coral reefs, have been adding their little mites to the growing mass of human knowledge, which has now become so vast that no one mind can grasp more than a small fraction of it. It is these small contributions that have done the work, each one perhaps serving as the foundation on which another is laid. The steel of one man's thought strikes fire from the flint of another man's brains. So long as they are kept apart they are but cold lifeless flint and steel; bring them together and they may explode a mine, or start a Chicago fire. Human knowledge is still in its infancy and there is still plenty of work for us all to do; new facts to discover; new fields to explore, or old ones to replow. And no field is so vast as the one into which we have been thrown.

Practical engineering science has been largely the growth of the last fifty years. At the beginning of that period, but little was known of the principles which control the construction of city sewerage, the purification of water, the calculation of the strains in bridges, or the application of electricity as a motive force. These branches of the science have all been built up since that time, not by any one great mind, but by the combined efforts of hundreds of laborers,

and still there is abundant room for investigation. To be convinced of the truth of this statement we need only compare the scanty pages of Brunell, and Dempsey, and Hughes, which were the sole dependence of some of us in our younger days, with the great works of Latham and Adams, and Waring, and Pierson, of Fanning and Humber; the first editions of Haupt and Whipple with the exhaustive treatises of Greene, and Burr, and Dubois, and Waddell, or even the first thousand of Trautwine's Pocket Book, with the last.

To show what important consequences may flow from an apparently trifling circumstance, let us take a single illustration from the history of this progress. Less than fifty years ago a bridge builder noticed that the chords of a bridge that had settled were bent more in proportion near the abutments than in the center. He mentioned the fact to one of the most prominent engineers of the day, and enquired what the cause was. The engineer could not reply; he had never observed the phenomenon, but the seemingly simple question started one of the trains of thought and investigation, which little by little, have led up to the present elegant theory of bridge strains.

Our recent field books are not the work of one brain, but rather collections of the happy thoughts and expedients of dozens of locating engineers in solving knotty problems, which had presented themselves perhaps for the first time in their field practice. And the field is by no means exhausted. We have just entered the outskirts. There is probably not a single member of this society who does not see, or hear or do something in the course of each year that is worth telling, and what the society wants, and what it has its annual meetings for, is that he shall tell it.

The great engineering societies of this country and of Europe are spending days and weeks in discussing matters that seemed to be settled years ago, trying new experiments, modifying old rules, measuring the effect of new facts, or the value of new theories, correcting past errors, and even quarreling about whether we should use the square root or the cube root of x in the formula for some insolvable piece of empiricism. And why should not we, in our less pretentious sphere do the same thing.

We, in Michigan, have a wide and varied field of labor of our own. Our lumber camps and saw mills, our iron and copper mines, and our quarries of stone and gypsum, our magnificent river and harbor and coast improvements, might furnish abundant material for papers, which would not only be interesting to us, but valuable outside the State. Other societies are gleaning in similar fields elsewhere, while we are neglecting our own. Why cannot some member from the northern counties take us into a virgin pine forest, and show us how to select camping grounds, to erect and furnish the buildings, to lay out the roads and organize the lumbering force; what tools are used, how the cutting and skidding and loading is done, how the roll-ways are broken, and the logs run to the mills, what each man ought to do, his wages and the cost of his work. Why could not another describe the modern machinery and processes by which the logs are taken from the boom and manufactured into lumber, with the score of little expedients which may make the difference between success and failure. No doubt, many of us have spent hours watching with ever fresh interest the isolated details of these industries, and could listen with equal interest to a connected and intelligent account from any one who was familiar with the whole subject.

Why cannot some one else explain how the wells are sunk which draw from the deep caverns of the earth the vast treasures of Michigan brine; the machinery employed, the difficulties met with, and how they are overcome; how the wells are kept in working order, and the brine which they produce converted into salt?

Why cannot those who have had experience in our river and harbor improvements, tell us how the works are constructed, the principles which control their design, and the difficulties to be met and overcome? Mr. Ripley has given us some excursions into this field, but we all have an appetite for much more. Our Northern Peninsula mining regions might furnish a feast of whose richness we may judge by the choice bits which we have had from Mr. Forster. The plaster mills of Grand Rapids; the stone quarries of Ionia, and many another

local industry might furnish the material for a valuable paper. All these things become so perfectly familiar to those who see them every day, that they unconsciously acquire the feeling that everyone else must be just as familiar with them as themselves, and yet I venture to say, that there are not five members of this society who could not learn much that would be new and interesting to them on any of these subjects. I might even go further and assert that an enterprising, wide awake newspaper reporter would find out in a few hours investigation, a good many things that none of us have thought of, to say nothing of numerous other things that are *not so.*

The economical geology and mineralogy and botany of Michigan furnish wide and almost fresh fields for investigation and discovery. How many of us could accurately describe the geological structure and history of our own counties, or all the varieties of timber to be found on their soil, their physical characteristics or the most profitable uses to which they can be applied.

There is still another extensive field in which some of our members might find material. Our city engineers might give us at each meeting an account of their past year's work, the experiments they may have been trying in new materials or methods for paving, or sewerage, or water supply, or perhaps the plan and treatment of a new public park. Several of our cities have been recently laying asphalt pavements. Who can tell us how they are succeeding under the extremes of heat and cold of our Michigan climate, or whether it has been found necessary to change the usual specifications to meet these conditions? Our railroad engineers might furnish us each year with maps of the lines they have constructed or surveyed, with the elevations marked on them, and the character of the soil and timber, and thus with little labor, add something each year to our knowledge of the topography and natural features of our State. Indeed, so many things occur to my mind which each one of us might have done that I am ashamed to further expose my own negligence.

Let us all resolve to do our part next year, even if it be but

a single page—without compelling our long-suffering secretary to ask us a second time.

In conclusion, gentlemen, permit me to express my sincere thanks for the unexpected honor which you have done me by electing me your president, and the hope that our relations may be mutually pleasant and improving.

E. W. MUENSCHER.

MR. APPLETON: There are so many suggestions in our President's message that go right straight home, that I would like to see it referred to some committee who would make some report on it. I move the appointment of a committee to take into consideration the President's opening address.

Motion being supported and carried, Messrs. Appleton, Granville and Skeels were appointed to act on the committee.

The committee having given the matter due consideration, made the following report:

To the President and members of the Michigan Engineering Society.

GENTLEMEN: Your committee appointed to consider the President's address, has very carefully considered the matter of preparing papers by members, to be read at the annual convention. We find that many members do very little towards providing matter for the good of the Society, in return for the valuable information they receive in the annual reports of this and other similar societies. Your committee admit to being somewhat perplexed to provide a remedy for this direliction of some of its members. We believe that in many cases this results from a feeling of diffidence which prompts many to think they have nothing new to say, or of interest to all members of the society; this mistaken notion keeps many pens idle, which might give many bright and valuable hints to the profession. Others are always ready and willing, and these are the contributors who fill our annual reports.

We dislike to heap more work on our secretary, but as the secretary and president are the best acquainted, and con-

sequently are the best qualified to carry out the idea of making a personal request of any member to prepare a paper for the use of the society, on any subject desired, and which request will tend to spur on modest members to give us their knowledge and make all partakers in their skill and ability, we recommend the adoption of the following:

Resolved, That when any information of any subject is thought to be for the interest of this society, the president or secretary, or both, are requested to ask any member of this society to prepare a paper, giving his knowledge or ideas on the said subject, to be read at the next succeeding annual convention, and it is the duty of every member to comply with such request.

Nothing in this resolution is to be construed to discourage voluntary papers by members, on such subjects as they think may be of interest.

Respectfully submitted,

WM. APPLETON,
JOHN GRANVILLE,
D. SKEELS. } *Committee.*

Report adopted.

Motion for the appointment of a committe on questions of practice being put, supported and carried, Mr. Hodgman, Mr. Strong and Mr. Rogers were appointed to act on the committee.

THE PRESIDENT: What is the pleasure of the meeting; are there any committees ready to report at this time?

MR. HODGMAN: I think there is only one standing committee that was to be called upon for a report now, and that is the committee on the World's Fair business. I was elected last winter as a member of the committee, to take into consideration the question of accommodations for the Michigan Engineering Society at Chicago, during the World's Fair. The thought was that the Civil Engineering Societies of the country were uniting together for the purpose of providing entertainment for all engineers who came from abroad—to have a special place of meeting, and the thought was that we might take part in such a movement as that. On investigation

I found that all engineers who wished to avail themselves of the privileges of this society, could do so by paying $5.00 a piece. My feeling was, that the Michigan Engineers, as a Society, wished to have nothing to do with it.

We have organized a local society in Kalamazoo—two members of this society are also members of that, Mr. Wm. J. Kirby and myself. They have obtained a good lot and are going to put up a building for the accommodation of the Kalamazoo people and those of the Michigan Engineering Society who wish to make arrangements for a home there. The arrangement is to furnish rooms suitable for two persons. The rooms will be rented at $1.00 a day. Any person wishing rooms can apply to the secretary of the society at Kalamazoo, stating at what time they want rooms, and have the rooms reserved for them. Nothing to pay until they have the rooms. It is two and a half miles from Jackson Park, and in connection with several roads, and we are planning for about sixty rooms.

MR. APPLETON: Is it for Kalamazoo people, irrespective of Engineers or anyone else, and are we allowed to become beneficiaries of this institution?

MR. HODGMAN: We propose, if the Michigan Engineering Society want accommodations there, to make arrangements to furnish them, only we would like to know before putting up the buildings, whether the society propose to avail themselves of it.

SOUTHERN CALIFORNIA AND ONE OF ITS WATER SYSTEMS.

PAPER BY A. L. REED.

The arid lands of the western portion of the United States and their reclamation is a question in which many are of late years becoming interested. As long as the fertile prairies of Illinois, Iowa, Kansas and kindred locations furnished such desirable fields for agriculture and gave such quick and oft-times easy and large returns for labor and investment, the development of the arid portion was little thought of by the general public, and only to the few was their real value known; but in the last few years the capabilities of these soils under skilled treatment, coupled with the salubrity of the climate in which some of them were located, and the almost fabulous returns they have yielded to their owners, has made the question of their development of special interest to many.

In character, as well as location, these arid lands vary greatly, the soil being all the way from a light sand to the heaviest clay and adobe, and the elevation from considerably below the sea level to several thousands of feet above. On most of these lands the annual rainfall is insufficient, and its precipitation confined to so short a period that without being watered by artificial means, crops cannot be produced at all, or only to a very limited extent and in favorable seasons.

The scope of an article of this kind is too limited to go into extensive generalizations, and will perhaps serve its purpose as well by confining it in general to the semi-arid lands of the coast region of Southern California, and especially to a single water system as therein developed; and to such limits will this paper be confined.

Lying westward from the Sierre Madre Mountains, and between their base and the Pacific Ocean, are the once semi-arid valleys and mesa lands of Southern California. These valleys differ somewhat in their conformation; the upper

valleys being in nearly all cases separate and distinct from the lower, the separation being made by a range, or ranges of hills. The upper valleys assume in many cases the form of more or less well defined basins, hollowed out, perhaps by glacial actions, and afterwards somewhat filled in with drift, and the wash and deposits from the stream; the lower valleys between the hills and the ocean, assuming the form of a broad sloping plain with comparatively smooth surface.

The streams as they issue from the mountains in narrow, and oft-times precipitous canyons carry, especially in times of flood, immense quantities of boulders, cobble stones, gravel, sand and silt which is deposited in the order named along their courses. Thus by annual deposits, the streams raise their channels above the adjacent lands and in time of flood often break away and seek new channels, leaving where the former channel was, only a mass of boulders, cobble stones and gravel; and oft-times impinging against a higher point of mesa land, cut it away, and with the sand and silt already in the water, carry it down to the lower valley to be deposited over large areas, making a very rich covering, but at the same time making the locality very uncertain in its character; for this season you may be on one side of the stream, the next on the other, and still the next in mid-stream.

The dip of these basins is, uniformly, from the mountains to the hills, and from each rise that separates the basins, toward the main stream and toward the point of its break through the hills into the lower valley. The lower valleys have numerous small streams breaking from the mountains, but they all find their way, when their volume is sufficient, into the main streams of the upper valleys, so that only main streams cross the lower plains, with perhaps the exceptions of the excess flood water from short canyons in the hills which, however, are soon dry.

A word of explanation just here, to those who are unfamiliar with the streams of the arid regions: They run, many of them, during the greater part of the season, as the expression is, "bottom side up," the sand on the surface and the water below, so that where in times of flood are wide, but shallow streams,

for the greater portion of the year is a small rivulet, or perhaps a broad expanse of boulders, gravel and sand. Many streams that emerge from the mountain canyons, quite large in volume, within a few miles have entirely disappeared and no water will be seen for miles, when they will gradually appear again in springs and form quite a stream, flow a few miles and again disappear.

The lands of the upper valley vary very much, running from a fine sedimentary sand to heavy clay, adobe, gravel, and in places almost entirely disintegrated granite. The lower valleys vary nearly as much, except there is an entire absence of the boulders and granite sand, and more of the fine alluvial deposits and some peat land near the coast in certain localities. Such in brief is the character of the streams, valleys and soils of the semi-arid region of Southern California.

Here, but a few years ago, and still to some extent, large herds of cattle and sheep found winter pasture, and the wolf and coyote roamed at will. Now the valleys and mesas are dotted with cities and villages, and covered with fields of waving grains, orchards of oranges, lemons, limes, olives and all kinds of delicious fruits, groves of stately eucalyptus, graceful pepper trees, with here and there palms, magnolios, and semi-tropical trees of many kinds. What has made the change? Simply the intelligent use of water. Where this water is secured, how conducted, how used, let us examine.

The earliest irrigation works were of the rudest sort, if indeed they could be called works at all. A settler, or a community of them, select some of the smooth, low lying lands adjacent to the stream and, going a sufficient distance above, dug a ditch having less fall than,—and gradually working back from—the stream, so as to bring it to the back or high side of his land, from which point it was distributed over it in rude ditches or plow furrows, and handled in a very primitive manner; the ditch being filled with water diverted from the main stream by a rude wing dam of willow bush and stakes which were washed away very often, and as often renewed, until the season's needs were supplied.

Many of the older water systems are still little better than

the one just described, although most of them have, at this time, some more or less modern appliances and methods.

However as the settlements increased, and the higher lands were occupied, and found to be in many respects more desirable than the lower ones, they were obliged to seek water from higher sources, carry it longer distances and by more skillful means. Finally, in the lower valleys the limit of the elevation was reached. Fine land lay above the highest water —high up the river there was no water, at least in sight— and a supply must in some way be found and perhaps conducted a long distance. To some of these more extensive systems let us briefly turn our attention. First, as to the sources of supply:

The lower valleys, in the primitive method just mentioned, soon appropriate all the lower flow of the streams; the upper valleys go to the mouth of the canyon and there divert the entire flow for their especial service, but this is not sufficicnt. The great flood stream of the rainy season must be secured, and held for distribution. Suitable locations are located, or settled in the mountains, dams built, and an immense quantity stored and distributed when needed. Notable examples of this method are the "Bear Valley," and "Sweetwater" dams, of which enterprises and the brains that conceived and the hands that executed, too much in praise can scarcely be said.

Tunneling into the hills and mountains, tapping springs and the underflow of streams, is another method that has, in some places, been very successful. Another, which is now receiving much attention, and which is being eminently successful in many places, is the development of the deeper subterranean water by means of artesian wells.

There has, in the region under consideration, been developed from a single well a flow exceeding two cubic feet per second.

Along the lower margin of the lower valleys these wells are very numerous, and in few cases has there been a failure to secure a flow; but most of the wells are of inconsiderable volume and only serve to irrigate a small area in their immediate vicinity; hence we shall give them only a passing notice.

In the upper valleys, however, there appears a different order of things. The different basins heretofore mentioned appear to be as entirely distinct in the subterranean, as in their surface waters and to have no connection, each with the other, and even different portions of the same surface basins appear to have their under surface waters entirely separate.

The "San Bernardino Basin," so called from the county and city of that name, has been the most developed, and has, and is, yielding large quantities of water. The San Bernardino valley lies almost wholly in the county of San Bernardino and is abruptly hemmed in on the north by the rugged Sierra Madre Mountains, while close on the east, tower the lofty peaks of Mount San Bernardino and Grayback, and on the south, by a range of hills extending from the mountain base to the hills of the Coast Range. Entering it from the northwest, in the Cajon (Cahoon) pass, from the extreme eastern end is the Santa Ana river; from the southeast comes in the San Gorgonio Pass, and between these, various smaller streams, some perennial and many only showing on the surface a portion of the year.

This basin has an area of about one hundred square miles, of which the artesian portion, as thus far developed, is something like twenty square miles. The artesian development of the Gage Canal system is in this basin, and the average of the first twenty-nine wells was thirty-three miners' inches per well. A legal miners inch in California is one fiftieth of one cubic foot per second.

The city of San Bernardino obtains its supply from the same basin, and there are various other systems of which there is no time to speak.

The development to which I shall briefly call your attention, is in Los Angeles county, and in what may be called the "El Monte Basin," of the upper San Gabriel valley, and through which, during the wet season, flows the San Gabriel river, which drains a mountain area of about two hundred and twenty square miles of rough rocky surface. The entire summer flow of this river is diverted at the mouth of the canyon, and supplies quite an extensive region contiguous thereto. There is below this division, for ten miles or more,

no surface flow; then, in the El Monte Basin, the water again gradually appears at the surface, and by the time the gap in the Coast Range of hills is reached it has become, from the springs and the inflow of some spring brooks, a considerable stream. All these waters are again diverted and used in the lower valley within a few miles of the Pass and the lower portion of the bed is again entirely dry.

The El Monte Basin is located in the middle of the upper San Gabriel valley, and the river at the point in question, just begins to show upon the surface.

In 1888, some Michigan gentlemen, who owned a tract of land in the lower valley, close against the foot-hills, and above the irrigation water of the valley, having failed to secure water by tunneling into the hills, determined to make the experiment of developing water in the Basin above referred to; and to that end, made a trial cutting, and sunk a test well, in which cutting they secured a generous flow from the gravel strata immediately below the surface and from the well a flow of about one fifth of a cubic foot per second.

Nothing further was done until 1890, when the writer was called upon to go and make a development cutting, and sink a series of wells, and if successful in securing water in sufficient quantities, to construct a main and distributing system, and a complete pumping system for the lands above the gravity flow. This system I shall briefly describe.

The fall of the river wash or bed through the El Monte Basin is from twenty to thirty feet per mile, and is simply a broad expanse of dry sand and gravel. On either side of the channel are benches a few feet higher, of similar material. Commencing at the lower end of a strip of land owned by these parties, which lies alongside and parallel with the wash, a Marion Steam Shovel was set at work. The cutting began at about six feet depth and gradually cutting deeper, running on a grade of about four feet per mile. This work was kept going with varying progress for about ninety days, and had cut into the sand, gravel and quicksand a channel more than one half a mile long, and from six to sixteen feet deep, and from twenty to sixty feet wide.

The material was very difficult to handle, or rather an excessive amount was necessarily handled, as from its nature, it caved and slid in very badly at times. In the bottom of this cutting was placed in sections, and secured, a wooden flume, four by six inside measurements, with cross sills of two by ten; longitudinal sills of two by ten; side posts and caps of four by four; and two inch plank sides; all of strong Oregon pine, and well spiked.

The excavation was made somewhat below grade line, and after the flume was secured in place, this bottom space was filled with coarse gravel to serve as a check upon the sand rising in the bottom, and, after two years of service, very little sand had come through the gravel bottom. The back filling along the sides was also made of coarse material, to allow as free percolation as possible from the quicksand and water bearing strata through which the cutting was made. From the cutting a flow of one hundred and fifty inches, or thereabouts, was secured.

During the progress of the cutting and fluming, work was prosecuted on artesian wells, and twelve were put down to depths varying from eighty to two hundred feet. Each one gave a greater or less flow, varying from one tenth to over one half of one cubic foot per second.

One remarkable thing about the wells, is the exceeding irregularity of the strata through which the borings pass, although in some cases they are within one hundred and fifty feet of each other. Although invariably a stratum of impervious clay was passed before a flow was secured, in some cases the clay was only a foot or less in thickness and in some cases twenty feet thick.

The method of sinking the wells was the ordinary sand pump, run by horse power, and was very rapidly and economically performed, the twelve wells complete costing less than two hundred dollars each, and being cased the entire depth with number sixteen double casing.

Having within ninety days developed nearly four hundred inches of water, we were warranted in proceeding with our work of constructing our main conduit and in order to do

this, must determine its grade, size, capacity, manner of construction, etc.

It was finally determined to make the conduit to carry fifteen hundred miner inches, or thirty cubic feet per second, on a grade of one in four thousand, with Portland cement, concrete sides, and bottom of the following dimensions. Neat bottom width, four feet, width 8″ below top, and at top six feet, depth 3′ 4″ figuring on a neat depth of water of three feet. The flumes, of which there are several aggregating over six thousand feet in length, are 4′ 6½″ wide, 3′ 4″ deep, and will be described in detail later.

Beginning at the lower end of the developement cut, the line of conduit runs a few hundred feet along the lower bench of the valley and strikes the foot of the bluff, and following along the line of, and gradually creeping up to a mile below, it is upon the mesa, upon the bluff; from this point the line strikes directly across the main valley of the river, by a flume and trestle, four thousand three hundred feet in length, to the mesa on the opposite side, thence across one quarter of a mile to the Puente Creek valley, which is crossed by a flume and trestle nine hundred feet long, and an extreme height of forty feet; the line then strikes the main range of the Puente hills, along whose steep sides and sloping base it follows for several miles till it crosses Sycamore Canyon on to the smooth sloping mesa, where it follows around the grade line in easy curves through the village of Whittier, to the East Whittier tract, which land it is the primary purpose of the enterprise to supply.

Along the hillside, in many places, too steep to more than obtain a foothold, the benching in was begun by hand, until sufficient width was secured to work a single horse or mule, when the material, when practicable, was plowed and pushed off by a side-hill scraper or "vee," until the grade line was reached, and the bench was eight feet wide and ready for the excavation; for the entire work has been made in excavation to avoid settling and washing away of embankments.

The first section of the work was put in December, 1890, and January, 1891. The excavation being in a fine soft sand,

the concrete was made of one part of Portland cement to ten of sand and gravel, just as they were taken from the river wash, very clean and good.

The specifications were one cement, three sand, nine gravel; but suitable material being found as stated, without screening, it was used one to ten, and made a very satisfactory piece of work. The larger portion, however, was made one to eight, the main body of the sides and bottom being 2½″ thick, the corners being reinforced and the upper 8″ being vertical on the inside, the outside having a uniform slope of one in three.

It may, perhaps, be not uninteresting to briefly describe the method employed in the work.

The excavation was first made to a templet the exact size of the outside. It was excavated by hand as it was found inexpedient to use teams, except to plow and loosen the material, and then strong horses were used tandem. The men became very expert in making the excavation the exact dimensions required, as, if too small the inspector objected, and if too large it took more concrete than the contractors liked.

Light skeleton forms were made of two by three pine, connected by one by four side strips, each being twenty feet long, and well braced. These forms were light enough to be easily handled by two men. They were placed in the excavation, neatly adjusted to position, and held firmly in place by iron pins driven in the bottom. One inch by twelve boards were used for the sides, put in one at a time, and the space behind them partially filled with fresh concrete, which was thoroughly rammed and packed; each layer or course being not to exceed 6″ in height; after ramming, the sides were carried up thus the width of 3–12″ boards, then an 8″ strip placed vertically completed the form. Behind this 8″ strip were placed thin wedges that were easily withdrawn, when ready, and the 8″ strip loosened and lifted out when the entire frame work was easily taken out, and placed on the bank, leaving the lagging to be taken out one board at a time. The alignment in places being very crooked it was found difficult to adjust the ends of the frames and lagging, and to obviate this strips of sheet

iron was used at each joint, which fitting behind the ends of the adjacent lagging boards covered the joint and greatly facilitated the work, these joints being the thickness of the iron —thinner than the remainder of the wall—were plastered over as soon as the forms were taken out.

The concrete was mixed at intervals on platforms of boards and shoveled directly on to a low hopper car running on a portable wooden track of two by four, laid in sections on the upper cross pieces of the frames. In this manner the mixing places could be made three to four hundred or more feet apart and the material delivered at the exact place it was to be used, and with a completely organized crew it was possible, and we did many times, put in as high as seven hundred lineal feet per day of completed concrete work.

As soon as the frames were removed which was as soon as the material had sufficiently set, a man, with fine mortar and trowel, followed, smoothing up the rough places, filled where necessary and trimmed up the work. Following him came the bottoming force who spread the concrete evenly over the bottom to the necessary thickness and thoroughly rolled it with a heavy hand roller filling the corners flush and tamping by hand. As soon as the walls were sufficiently set, they were given a heavy coating of neat cement wash of the consistency of thick cream, applied with a heavy white-wash brush, which gave the wall a good finish, filled the pores and made it water tight.

The concrete conduit is covered the entire length with pine or red wood plank from two to four inches thick, spiked to three two by three longitudinal strips with 20d spike. The outside strips are pressed firmly against the vertical face of the concrete and make the whole very firm and solid. The planks except through the village and in special places, are not covered with earth and are cleaned of all dirt and rubbish each season. At intervals of two thousand feet or at each 6″ fall, bulk-heads are placed, or rather slotted recesses are made with concrete so that flash plank can be slipped in them, making a reservoir of the entire conduit if necessary. At intervals not exceeding one thousand feet, are placed man-

holes and ventilators in the covering made two feet square at one end, nothing at the other; the large end screened by a removable screen of six by six, mesh number 22, galvanized wire; these are secured in place by a common lag screw whose head goes into a countersunk casting so that it can only be reached and turned by a special socket wrench.

At convenient points, when necessary, outlet valves are placed solidly in the concrete 8, 10 or 12″ opening, with a planed faced slide valve through which the water may be let out for any purpose, and below these gates suitable weirs for measurement are constructed. At intervals suitable waste gates are provided, and near the upper end are several sand boxes for catching and dumping any sand that may be deposited.

This method of construction is practically a new thing in California, no very extensive work of the kind having been, as far as I am aware of, previously attempted; nearly or quite all cemented conduits having been very small, or else having a cobble stone or rubble backing, with cement pointing or facing. This system has so far been a success, having stood some of it over two years and doing good service.

The six thousand or more feet of flumes in the system are built of 2″ Oregon pine dressed, shiplaped and asphalted, and present no special feature of construction. Across the main river valley the trestle consists of three pile bents of ten by ten pine piles well driven, spaced twenty feet centers; the outer piles sprung to a slight batter, 8 by 10 caps drift bolted, 4 by 14 stringers, 4 by 6 ties spaced, 4 feet centers.

The flumes as well as the development flume are all covered with 1″ redwood to prevent any contamination of the water, which is of the finest quality, and to prevent the growth of moss and fungi. The short trestles across canyons are on redwood mudsills and are lighter, six by six main and four by six batter posts with the ordinary diagonal and longitudinal bracing. The main system as at present constructed is about eleven miles in length, and has in connection at the lower end a complete pumping plant, reservoir and distributing system, to supply the lands above the gravity flow, and close to the hills

which are practically frostless and very valuable for the raising of lemons and winter vegetables. The plant consists of a complete set of pumps of the well known make of our own Mac Walker of Port Huron, of one million five hundred thousand gallons daily capacity.

The water is taken from a pumping cistern ten feet in diameter and ten feet deep, and pumped through about thirty-three hundred feet of 8″ Kalamein pipe to the reservoir, which has a capacity of eight hundred thousand gallons.

Connecting with the main, are the distributing pipes with outlets with gates as required. At each outlet is built a weir box of Portland cement concrete of varying size according to the pressure on the pipe, the less pressure the smaller the box may be, as the surface of water in the box and over the weir should be reasonably smooth in order to secure accurate measurement. The measurement over a weir is coming to be the usual form in use, instead of the square inch under a 4″ pressure, and is much easier to handle and regulate. The weirs on this system, that is, on the pipe lines, are all twelve inches wide and on the back of the weir boxes is placed a scale graduated to one-fourth inches. In the use of the water, the depth of flow and time are noted and recorded, and the flow per minute in gallons taken from a table prepared for the purpose, and has been very satisfactory.

In June, 1892, over six million gallons were pumped and the record of water used was within about fifteen thousand gallons of the same amount. Meters are used on all service connection. So far the Crown and Nash meters have been used.

The reservoir is seventy by one hundred and seventy-five feet in size at top, twelve feet deep with inside slope of one to one, and cemented four inches thick with Portland cement concrete, given two coats of neat cement wash; it is tightly covered with a light roof of sawed redwood shakes, and well ventilated at top and ends and all openings screened.

From the weir boxes the water is conducted either in cement or vitrified pipes under ground, or in small flumes of redwood, or in small surface ditches to the points desired on each subdivision, or lot, and from these points distributed over

the surface in various modes of which in detail we have no time to speak.

From this brief sketch you get some little idea of a water system and in general of the lands and waters of Southern California.

There are thousands of acres of the most beautiful lying lands still unimproved, and ample water yet undeveloped and unstored to bring them all into utility. It requires only capital and skill and a little time to accomplish the end and make "Our Italy" as nearly like the "Garden of Eden" as is possible on this earth on which we live.

MR. HODGMAN: There is one thing I want to say in connection with this paper. I do not think there is a harder working man in the Michigan Engineering Society than Mr. Reed. He has practically everything to do, engineer, superintendent, book keeper and everything else. He doesn't have a minute to spare, but whenever he could find a minute, he sat down and wrote. The men who really have the most work to do are the men whom we can best depend on to do their share of the work of the society.

MR. JOHN RANDALL: This question of cement lining is quite interesting to me, because I tried such a thing four years ago. It was in loose sand, and with only one and one half inches of cement, we hold water to the depth of sixteen feet. It has been in use four years without any leaks. I recommended that the sides should be bricked up and the bottom should be concrete and the sides and slopes should be brick, but the capital of the company would not warrant that, and they told me that I must arrange on something cheaper. As an experiment,—I thought it was an experiment to make such an egg shell as that—but we dug it out, being very careful not to disturb the sand as it was originally put down, not to break the walls, and just before the cement was put on, the mason went ahead with the trowel and shaved it down to the undisturbed sand, and put one layer of cement on while it was yet moist. We did not use any gravel in the concrete, but used a very good quality of sand, using about five of sand to one of cement.

MR. GRANVILLE: Is this a reservoir, carrying sixteen feet of water, with only a 1½ inch wall to hold it, with nothing in the bottom to hold the soil?

MR. RANDALL: Yes, but it has a good many feet of natural soil.

MR. GRANVILLE: I know, but on the bottom. Would the weight of the whole structure help strengthen the walls?

MR. RANDALL: I think the only strength it has, is in the natural packing. The land has been there, we don't know how long, pressed down by the soil above it, until it is more solid than we can get it, in any other way.

THE PRESIDENT: What slope did you give to the sides?

MR. RANDALL: We made it egg shaped, except that we had a flat place on the bottom. I think the slope as it started near the top was about one in eight, and then the slope grew greater.

THE PRESIDENT: Then it was a good deal steeper than the natural slope?

MR. RANDALL: Yes.

THE PRESIDENT: It would be difficult, it appears to me, to keep the sand from sliding in while getting the plastering on?

MR. RANDALL: We did not allow the excavation to get ahead of the plastering. We put on a thin coat to hold it, and waited until that was set before going any further. It did not cave a particle.

MR. APPLETON: It must have been a good place for that kind of work?

MR. RANDALL: Well, it was all sand.

MR. APPLETON: You couldn't use a form?

MR. RANDALL: No, just plastered right on the sand bank. It was a very simple affair, but in a good many places it would not stand.

MR. APPLETON: That is a new idea to me. I don't think under the circumstances, I should have thought of holding that much of a head of water with that amount of plastering, but I don't see why it wouldn't work.

MR. RANDALL: The natural soil holds it. The plaster is merely to keep it from leaking. I would be almost ashamed that I had any connection with such a job if it hadn't stood for four years.

MR. HODGMAN: If I understand, it was nothing more than a big cistern.

MR. APPLETON: What kind of cement did you use?

MR. RANDALL: The best Portland cement.

MR. BEAN: Commencing at the top and working down?

MR. RANDALL: Yes, we dug the sand away all around the margin to the depth of a few inches, and then plastered right on to the bank, and so on one course after another as the sand was excavated from the resevoir.

MR. HODGMAN: It seems to me that is the distinguishing point of the whole thing, *i. e.:* the manner in which the work was carried on. This was simply a big cistern, and I have seen lots of cisterns dug in the sand and plastered over with cement without any backing, which held water and stood indefinitely. I have one myself, egg shaped, which is ten feet deep, and holds over forty barrels. The hole was dug, and it was plastered right into the sand about an inch thick with mortar made from common water lime and sand. The top is arched over with brick, but the first layer of brick was laid right on the sand at least six feet above the bottom of the cistern. That has stood nearly twenty years without cracking or leaking.

MR. SKEELS: Mr. chairman, I think the principal point is the absence of any thicker backing.

MR. RANDALL: The natural earth is there, and before it was excavated, the weight of a cubit foot of the original earth was probably more than the water to be put in there afterwards. The natural soil is backing enough, and therefore you are going to a needless expense in putting in brick, etc. As far as holding the water, the natural earth is enough.

THE PRESIDENT: I do not consider that it is at all remarkable that it will hold water—it is stronger after it is full of water.

MR. APPLETON: The trouble would be at the time it was empty. You get a pressure of ten feet of water at the bottom of that well, and if the earth is at all compressible, a thin wall like that is liable to crack. The pressure at the bottom of that cistern is a good deal heavier—it isn't like a body of earth.

MR. HODGMAN: Isn't sand about the least compressible earth we have to deal with?

MR. APPLETON: But in speaking of the resistance from the inside or outside. The resistance is practically the same at the bottom and top of that well, on the outside of the well where you have the backing of sand, but the pressure is greater at the bottom of the cistern full of water than it is at the top.

MR. RANDALL: You have got to bear in mind that this is egg-shaped, and the pressure from above would distribute it all over.

THE PRESIDENT: I suppose that the safety of the structure arises from the fact that you were careful not to allow any loose material to get in the lining. All of us know there is nothing better than sand, so long as you can keep it confined. It is better than solid rock, provided you can only keep it confined, and in this case the precaution seems to have had its effect; but it certainly is an extraordinary case, and it is just these little tricks of the trade that we ought to have brought out in these meetings of ours.

MR. GRANVILLE: How was the water put into the cistern after it was finished?

MR. RANDALL: Pumped in through a pipe in the side. There was a four inch main put in while the reservoir was being constructed. The last thirty feet was driven from the inside, by working the dirt out of the inside of the pipe, so as make sure that the sand was tight outside of the pipe.

SPECIFICATIONS.

BY G. L. WELLS.

Specifications prepared for proposed engineering works are for the purpose of giving every person connected with the work an accurate idea of the *quality* of the work to be performed and materials furnished. They should also include a statement of quantities, as nearly as can be arrived at from the amount of preliminary work which the projectors choose to spend in gathering the necessary data.

Most corporations having work of any magnitude invite contractors to bid upon it, offering as the basis of the bids and contract a set of specifications, descriptive of desired materials, manner of placing, and quality of workmanship.

The specifications are supposed to have been prepared by a competent engineer, whose skill and experience will be manifested in the specifications themselves.

But is this always the case? An advertisement for bids generally secures a number of proposals from reliable contractors who desire the contract for the profits which can be realized by their skill in management.

As labor and material cost money, the contractor has to figure upon the cost of these in making up his proposal. When he comes across a paragraph like the following, how can he determine quantities to be used?

"All mortar used for masonry and concrete shall be made of fresh hydraulic cement, of such brand and strength, and mixed in such proportions as shall satisfy the engineer in charge."

It is a principle in law, that in making contracts, minds must meet.

Where could minds meet on the quality of mortar to be used by such a description, when cements are in the market which vary in cost from 60 cents to $4.00 per barrel, and the proportion of cement to sand are demanded from ratios of 1:1 to 1:3?

The mind of the bidder at least, in this case, is puzzled instead of meeting the mind which produced such a description, and the engineer gains their contempt instead of respect.

An invitation to bid upon a complete pumping plant without telling distances between boilers and pumps, or giving drawings showing their relative positions, leaves each bidder to supply what ought to have been given them exactly, or to bid upon a stand pipe which has only a definite description of diameter and height, leaves each bidder to supply a set of specifications of thicknesses with varying factors of safety.

A fair comparison of bids can hardly be made from such specifications, and the engineer who made them merits the contempt which both his employers and contractors heap upon him.

"Any extra work required under this contract shall be executed as directed by the chief engineer, and shall be paid for at a price fixed by him, which shall be final and conclusive."

The above expression is often met in specifications, and to say the least is a one-sided bargain.

If the engineer is known to the contractor, and his fairness established, the matter is not so uncertain; but in the present day of competition, it is no unusual thing to find contractors traveling from one thousand to two thousand miles to bid upon work, and it is then impossible to know what to expect from an engineer who is an entire stranger to them, and compensation for extra work ought to be stated in a more definite and certain manner.

Customs of workmen, such as brick and stone masons, plasterers, painters, etc., in measuring work differ materially in different localities and the method of work should be accurately described. For instance, if a man makes a bid calculating that 128 cubic feet make a cord of stone, and then when he comes to do the work finds that all local contractors and masons figure 100 cubic feet in a cord, with all corners figured twice, he furnishes 28 cubic feet for nothing.

There is an effort being made by many engineers to reduce such work to a uniform practice of measuring such work by

the cubic yard, actual measurement, and do away with the senseless customs used by workmen, which differ even in the same state, but the knowledge of this reform has not reached all parts of the country yet, as many recent sets of specifications will testify.

In short, if an engineer will constantly keep before him the *quality* and *quantity* of the work, his specifications will be such that contractors can figure intelligently, and will avoid future misunderstandings and litigation.

It is not always possible to give an exact statement of the gross amount of material to be used in the work. It can be approximated near enough for practical purposes, but the unit of measurement should be accurately defined.

The quality of the work can always be described in such certain language that no one can mistake its meaning, and a man who cannot do so is not worthy to be classed among engineers.

THE PRESIDENT: It is very certain that a man who has occasion to consult specifications for public works comes across some very queer specimens.

MR. SELLERS: I would like some of you gentlemen to call at my office. We have some specifications prepared by Mr. LaRue and myself, that I think cover this ground entirely.

MR. GRANVILLE: Measurements ought to be put in cubic yards. The difficulty is in measuring masonry where there are openings, and there will always be difficulty in settling with contractors, unless these matters are put into specifications. It is a matter that requires a great deal of care, but as a unit of measurement, we should not think of anything but a cubic yard. There is one extreme that engineers are likely to run into, and that is to tie the contractor down so tight that there is no chance for him at all. I have seen specifications so severe, that it would be impossible, in nine cases out of ten, for any contractor to comply with them. To be sure, there is opportunity given to the engineer to let up, but that is an objectionable feature. Nothing should be left simply to the judgment of the engineer, unless it is something that cannot be

foreseen. Circumstances are liable to arise in the execution of any important work that cannot be provided for, but where it is possible, it should be done in the specifications. But they should not attempt to be so severe with the contractor that he cannot carry out the specifications, as they are liable to drive away honest men.

MR. APPLETON: That is a good point. There is too much in many specifications—more than anybody has any idea of carrying out. If a contractor figures on carrying out a contract to the letter, he can never compete with others who do not expect to carry out the little points. My idea is to put what is absolutely necessary in the specifications, and leave out that part which you do not intend to enforce.

THE PRESIDENT: By attempting to put in too much, you are very apt to compel men, who intend to be honest in their bids, to put on a good deal higher price than they are really willing to do the work for.

MR. GRANVILLE: Of course, sometimes, if you happen to know the engineer, you are all right, but you have the advantage of some other man who doesn't know the engineer. I mean by that if you know the habits of the engineer, and his custom in enforcing his specifications, you have the advantage of the stranger.

THE PRESIDENT: And there is a great difference in engineers—in their judgment in the enforcement of specifications. Some men will insist on the exact performance of the specifications when the thing is almost impossible, while an old, experienced engineer, who has had a great deal of that kind of thing to do, will know when to require exactitude and when not to.

METHODS IN VILLAGE AND CEMETERY SURVEYING.

F. L. CHURCH.

Doubtless all who have had experience in surveying village and cemetery plats know the difficulty of getting measures on parallel lines to agree, particularly when the ground is uneven or obstructed to any extent, as it usually is in standing timber. We are also well aware that it is impracticable to run successive lines with a compass that will be exactly parallel without correcting them. If the work must be done with a compass, then lines should be measured and stakes set on opposite sides of the plat, and lines opened and corrected between these stakes, before the staking is done. But I think that an instrument that will measure angles is, if not indispensable, at least very desirable, and any surveyor who wishes to do this kind of work should provide himself with one. The methods that I wish to mention were worked out with a Gurley Reconnaissance Transit, trying to overcome the difficulties I have mentioned.

While I do not claim that they are better than any other, I have found them useful to me.

Of course the first thing to ascertain, is the plan of the plat, and if the adjoining sides are not at right angles, then the side to which the lots are to be squared must be decided upon. I have known of plats being laid out with adjacent sides of all lots not at right angles, but it seems to me that this is a very undesirable plan; still it is a point to be decided by the proprietor rather than the surveyor. Then if the land is tolerably level, measure either at right angles with or parallel to the guiding line, carefully set a row of stakes, marking the exact point with a tack, measuring and sighting again after the stake has been driven solid. Sometimes it takes considerable explanation to make the "hands" comprehend your plan, though if they are men of usual intelligence, they will learn it in a short time. That is one way in which land surveyors are

at a disadvantage with railway surveyors, because they must get along with untrained men in most cases, and by the time the men begin to know how to do the work well, as you want it done, the job is finished; and for the next, a new set of men have to be got along with. This makes it necessary to watch the work for errors and to check measures in every way possible. At one time after telling my men what to do, so I thought they understood, instead of measuring and lining on top of the stake for the position of the tack, they drove the tack in top of the stake, and then set the color pole on the tack, and if it was not right, tried to move the stake to get it right, which is a troublesome thing to do. This row of stakes being set correctly, select a line at right angles with it, which will give the best ground to measure on and set and mark stakes in the same way. These two lines of stakes will be the frame work of the plat. It will usually save labor to set stakes while running in the direction in which they stand closest together, that across the ends of the lots.

Having decided which way you will run while measuring, put sight pickets at each end of the base line which is at right angles to the lines you will run, and at all needed points, to have one or more in sight from every stake on the base line; being careful to get them set firmly and exactly right. This is best attended to when running the line; commencing at one end of the plat, set the transit over one of the tack-marked stakes, ranging it by the pickets, and then turn the telescope 90° and open and measure the line. Except the first few stakes, set the stakes lightly, so that they may be moved if they need it, to correct the measure.

A good way to measure, is to have one of the chainmen set the marking pins where stakes are to be set and let the stake driver follow with the stakes, but not move a pin until the next one is set, so as to measnre from a pin and not from a stake. Proceed in this manner until the stakes are set.

Now, to correct these stakes, place pickets on the base line parallel with lines to be corrected the same as on the first base line. Then set on this base line, as before on the other, and then turn 90° and sight through to each stake, thus crossing

the lines run before, and move each one that needs it, to make it agree with the measures on the base line. It probably will not be necessary to cross-sight every row of stakes, but one in three, or the more important ones if the plat is in timber will answer, and save work; as one or two may be measured to, and corrected each way from those that are sighted. If the lots in different parts of the plat lie in different directions, each part would have to be worked as though it was an independent plat. Different sized lots would make more base lines necessary.

Sometimes on account of rough or hilly ground, better results will be obtained by making one line a base line part way, and another the rest.

To illustrate my meaning, I will give an example: The northwest corner of a plat I surveyed was at the foot of a hill facing west, and it was steep enough to make a correct measure difficult. Along the west boundary it was nearly level and the hill turned to the east, so that on the south part of the plat a level line was obtained long enough to reach as far east as the top of the hill on the north side of the plat, so I corrected the west end from measures on the south side of the plat and then ran a line at right angles up on top and across the hill, and corrected the east end from a base line near the north side. The stakes were set running east and west.

Another plat had a bold hill projecting into it from the east, and in order to get a correct measure of the east boundary as well as correct location of two rows of stakes over the hill, I ran a line west parallel with the south boundary, then went north with the east boundary until I got north of the hill, then ran back parallel with the south boundary, and am satisfied that I got better results than I could have got by measuring over it. On hilly and rough ground there will often be a chance for the exercise of judgment in deciding where to locate base lines, and no rule can be given, except to make measures to correct from, carefully, on the best ground you have, and start all measures from lines which are as correct as you can get them. The angles of the boundary must be correctly measured, and the stakes on or next to either of them and not parallel with either base line can still be run from the

intersecting base and corrected from the other, by knowing the angle. If lots are not right angled, but have their sides parallel to one boundary and their ends to the other, the same plan can be used by turning the proper angle instead of 90°. It will help to avoid mistakes in turning angles to always keep the limb so that the vernier reads 0 with the telescope directed along the same line, or direction, say the one running nearest north, then note the reading on the limb when turned in the direction of each line of the plat.

The same method may be used in cemetery work to good advantage when quite a number of lots are laid out of the same size. In curve and irregular work the bearings may still be taken by angles from lines, the direction of which is known, taking care to have a sufficient number of hubs or turning points on all lines likely to be used for this purpose, as well as at all points where lines in different directions start, to be able to get the direction of the line wherever it is needed. It will be seen that the object is to get the lines correct in direction without correcting them, which may be done within narrow limits by angles from lines the direction of which is known, if care is taken; and to make all measures agree with those that are presumably the best.

I wish to make a query in regard to the location of monuments. Though it is not covered by the title of my paper, it is closely related with it. Where is the best place to put the monuments for the intersection of streets or streets and alleys? If they are put at the intersection of side lines, that is, at lot corners, they are in the way of fences; if put in at the center intersection they are handy to work from, but are apt to be disturbed in making and working the street, and if the streets are ever made good will be destroyed, or be badly in the way. I have set some both ways and do not like either. I think now that a good way is to set them four or five feet from the lot corner. I have set some in this way putting them in line one way with the stakes and four or five out in the street the other way; at alleys I put them in the center of the alley.

I should like to know the opinion and practice of others.

My purpose in writing this has been as much to find out

the methods of others as to give my own, as I have never seen any description of methods for this purpose, and if I can get anything better I should like to do so.

METHODS EMPLOYED IN LAYING OUT A TOWN PLAT.

BY A. J. TEED.

During the past summer I have had occasion to survey and plat into town lots a tract of about 300 acres. Some of the methods employed in doing the work may be of interest to surveyors, even if they are not new or instructive.

The land was nearly level and while covered with stumps and logs, there were no more trees or bushes to obstruct the line of sight than could be removed. I could get in all cases, an unobstructed view, and on some of the boundaries there was a good place to measure, so there was no reason why accurate work could not be done.

As the land was likely to become valuable, I determined to forstall the future profits of lawyers, accruing from litigation that should arise over my mistakes, by doing accurate work.

The land was bounded on the north by a level and well cleaned wagon road, and was traversed by three straight railroad lines. These roads afforded an excellent place to measure, but the east and west quarter line, the west section line, and the west boundary of the plat must be measured over stumps and logs. To make the measurements on these lines agree exactly with those on the railroad was the task I undertook to accomplish.

Owing to the right of property owners, it was necessary to make the streets conform to the government survey. As the government surveyors did not use a transit and steel tape in their survey of this section, the angles were not right angles, and the lines were not straight. In fact, there is not a single right angle in the entire plat. Those angles that appear to be right angles, vary from 3 to 18′.

I ignored the eighth lines and made all east and west streets parallel with the east and west quarter line, and all north and south streets parallel with the north and south section line. As the plat is partly in two sections, this made a small angle in each street as they cross the section and quarter lines.

The method employed in the survey was to work from the outside in, from the great to the small. The boundaries were first established, and then the interior street lines were run, setting monuments at their intersections. The blocks were then subdivided into lots.

A brother surveyor once remarked to me: "That he knew of some men just mean enough to kick, if a surveyor varied a foot in the boundary of a lot." In this plat I believe that there is not a single block the boundaries of which vary more than one inch from what they were intended to be, and as each block line is again sub-divided into from 6 to 8 parts, I believe that the greatest average variation of any one lot will not exceed one-fourth inch, and generally, it will not exceed one-eight to one-sixteenth of an inch from the size it was intended to be.

If it takes a mean man to kick on the variation of one foot in the size of a lot, the exact amount of meanness a man must possess to kick on this survey can be mathematically calculated by the principle of general average.

The transit used in this survey I put in perfect adjustment, so far as the line of collimation is concerned, but I did not have confidence in its ability to measure an angle to less than 1′. But in all the principal angles I took at least four independent observations, as the sum of all the external angles in the principal triangles over quadrilaterals equaled four right angles to within less than 1′. I feel confident that I have all the angles correct to within less than ½′.

The labor of making the measurements was facilitated by the presence of the three railroads that crossed the plat. The east and west quarter line had to be measured on the natural ground. I measured the line three times and the greatest variation was 1½ inches in one-quarter mile.

To get the correct distance between the streets on the

north and south lines, I carefully measured the angles of the two north and south railroads from the north and south streets, and multiplied the secant of these angles by the distance between the streets, and laid that distance off on the railroad and put in points.

At first I thought that a variation of a few minutes in the angles of the railroads would make no perceptible difference in the length of the secants, but I found that to make the distance on each railroad from where they cross the quarter line to their intersection agree, the angles must be exact. That a a variation in the angle of the Cummer railroad of 2′ would vitiate the entire survey.

Having established the points for the intersecting streets on these two railroads to my satisfaction, I proceeded to measure the west section line. The ground here not being so regular, it was more difficult to get an accurate measurement. After measuring the line carefully as I could, I found it necessary to add nearly one inch to each block of 366 feet, to make the entire line agree with the calculated distance as determined by the measurements on the railroads.

Having established points on the two railroads, and on the section line, I set the transit over each point on the Cummer railroad and back-sighted to a flag held on the G. R. & I. railroad, and then ahead to a flag at the corresponding point on the section line. In every case I found the line practically straight.

Assuming that to be correct, all intermediate points were lined in, independently of the chaining.

The point on the north and south streets were set by sighting from the north boundary to the quarter line, and from the quarter line to points on the T. & A. A., set in the same manner as those on the north and south railroads.

As I had on this survey most of the time only one man to assist me, all the intermediate street lines were chained; but no attempt was made to do the work accurately, and the lining was all done with the eye.

It is an easy matter to thus set points 300 or 400 feet apart, that will not be more than three or four inches out of place,

but to set them so that they will not vary more than one-half inch by the chain alone, is a very difficult operation. The intermediate points thus set by the chain, which were approximately correct, were then lined in with the transit.

During the progress of the survey, the intersecting points were marked by small pegs, about one inch square, and points marked on them by means of tacks. By using small pegs, a man can carry enough for a line a half mile long in his coat pocket, or tied up with a string, without being a burden to him; thus saving the expense of an extra man to carry stakes, besides, small stakes can be inserted in the ground more quickly and more accurately than large ones. After these points had all been established, they were replaced by pieces of gas pipe three to five feet long.

In order to get the gas pipe in the right position, I used a stick about three feet long with a little notch cut in the middle, and one near each end. The middle notch was laid exactly over the tack, and a pin inserted in the ground in the notch at each end. The stick being removed, the gas pipes were then driven in the hole where the peg stood, nearly to the surface of the ground; the stick was then replaced and the pipe was wedged over to the exact position and driven out of sight.

In this plat, the north and south streets all make an angle of 8′ on the quarter line, and the east and west streets make an angle of 18′ on the section line. To test the accuracy of the chaining this angle of deflection was measured on each street, and when it did not read the same, the error was discovered and corrected, so that on the entire plat the work of the tape was everywhere checked by the transit, and the work of the transit was checked by the tape. Perhaps the most interesting part of this surveying was my experience with tapes.

I used on this survey a tape obtained from Justus Roe, in connection with an old Hodgman tape, which I had adjusted to a standard tape which I had had for fifteen years. The Roe tape was just a quarter inch shorter in a 100 than my standard.

In using the Roe tape I attempted to make the work agree with my old tape, by adding one quarter inch per 100 to each

line measured. But upon trial I found that this was not enough. Measuring one-half mile along the level grade of a railroad track, the best place in the world to measure, after allowing the quarter inch per 100, the Roe tape was still too short. I can account for this difference only by the different methods in which the pins are set. In my old tape the distances are taken from a line on the tape held to the *center* of the pin. In the Roe tape the distances are taken from the *front* side of the pin.

Theoretically, these methods ought to give the same results, but the two tapes would not measure the same, and I found the difference to be about one quarter inch in 400 feet.

This difference however, is comparatively small, and might, I suppose, be eliminated by more care in setting the pins, But which of these two tapes is correct, as to its recorded length?

My old tape I obtained from Hodgman, but as I found it one-half inch too short, I regraduated it to agree with my standard. This standard I obtained from Gurley and have compared it with a number of good tapes, and believe it to be right. Recently I compared tapes with the engineers of one of our railroads, and his tape did not agree with any of mine. Now which of these four tapes is right? My Gurly tape is warranted to be correct according to the U. S. Survey thereof.

The Hodgman tape is made from a steel rod furnished by the Government, and is absolutely correct.

The Roe tape I returned, because it was too short, and they write me that they have compared it with the U. S. standard, in the coast survey office of the city of New York, and it is exactly correct.

The railroad engineer's tape has been tested by the Supreme Court and must be right.

Here are four tapes, each one warranted to be correct by the U. S. standard, and yet each one is different. The greatest difference being one-half inch; the Gurley tape being the longest, and the Hodgman tape the shortest. It seems to me that there are about as many U. S. standards as there are

political parties. The democrats and republicans on the extreme, and the prohibitionists and the peoples party waging between. If there is a member of this society who has a tape which he knows to be correct, I would like to obtain his photograph, not of his tape, but of the man; for I am tired of looking at absolutely correct tapes.

THE PRESIDENT: Gentlemen, these papers are before you for any discussion. If anybody thinks it is easy to lay off a large piece of land, and come right every time, he will find it easier than I ever did.

MR. BEAN: If they can make the second measure come out like the first, they can do better than I can.

MR. HODGMAN: My general method has been pretty much the same as Mr. Church's. I have a son who has worked with me ever since he was old enough to carry a pole in his hand, until he left me for a better job. After having laid out these base lines, I have run the interior lines and set the stakes without measuring at all, by sighting both ways—with his assistance—and all the interior work was done by sighting both ways. I stand on one line and sight toward a picket on the opposite side of the block; my son stands on the other line crossing it and sights to a picket the other way, and the rodman stands with a rod held plumb, moving it as we direct, until it is exactly in line both ways. All the stakes are rapidly placed in line both ways without measuring any but the outside row.

THE PRESIDENT: That will answer very well where the ground is perfectly clear of timber, but suppose you are in an old pinery ground covered with logs and blackberry brush?

MR. HODGMAN: Do the best you can then.

MR. HUBBELL: I have had a little experience on rough land, and have tried Mr. Hodgman's plan, and found it very satisfactory, especially over rough land. I have often used two instruments, having a man who was capable of using one himself. As for monuments, I had supposed that the centre line of streets and alleys was the proper place. I have used a ¾″ iron rod, driving it to the surface of the ground, and then witnessing it by some temporary post or stick, that would indicate the approximate neighborhood.

MR. HODGMAN: A few years ago I took occasion to write to the civil engineers of nearly all the leading cities of the United States, asking them the question as to what kind of monuments they used, and where they were placed. The result was a very motley set of returns, which showed that very few of the leading cities had any monuments worthy the name. We found some of them set their monuments on the angles outside of the street, at the margin, right on the corner lot, some in the middle of the street, and some of them set them on some arbitrary line—some line, neither the centre of the street nor the side line. I made up my mind that the best place of all, even supposing they are liable to be disturbed, is the center line of the street, and make enough observations to permanent objects near by, so we can re-locate the point.

MR. HUBBELL: That is the best place undoubtedly, until you begin to put sewers into the street.

MR. HODGMAN: Of course that is the trouble—their being destroyed,—but as I said, I would take enough references to permanent points, and then I would make it a punishable offence to disturb them without the authority of the engineer, and see that they were punished if they did it.

THE PRESIDENT: And to do that, you would have to make one man judge, jury and executioner, otherwise you couldn't do it. In Manistee there was a time when there were a great many good monuments, and not half of them can be found now. They were almost all left, and pretty well taken care of until we began to put sewers in. I supposed the location of them, as Mr. Hubbell says, was arbitrarily settled by law; that they had to be at the intersections of streets and alleys.

MR. HUBBELL: I wrote to the Auditor-General in regard to that point, and he says that any of those points, if uniform throughout the plat, will be accepted at their office as correct. I have set some at the lot corners, some on center intersections, and some four feet from lot corners, and all were accepted.

MR. HODGMAN: What do you use for monuments?

MR. HUBBELL: I have used gas pipe considerably, and I have used cedar posts, a foot or more long.

MR. ALBERTSON: I was a little surprised in looking at the plats in the Auditor-General's office, to see that one of the permanent monuments consisted of an oak stake 1½ inches square and 15 inches long. That might be serviceable in a town with a junk shop!

MR. HODGMAN: We want for a monument something that is not liable to be destroyed by the boys. There is a post that is made by a Jackson company, but it has to be protected because it is readily broken. A good wooden stake well driven is a more permanent monument than a wrought iron rod or gas pipe. The stakes, although they rot away, will yet, if they are driven below the surface dirt, last indefinitely. I have dug them up where they had been down for sixty years. The rotten wood is just as good a mark of the location as the sound wood is, and in some localities it will last an unknown length of time.

MR. SELLERS: This summer I platted a sub-division. At the corners I placed stakes four inches square and two feet long; the intervening lot stakes were 18 inches long, and no questions were asked as to what they were or where they were placed.

MR. VINCENT: When they come to build fences, what becomes of those corner stakes?

MR. SELLERS: The corner stakes are more liable to destruction than the center lines. You may take the greatest pains, and the first thing they do is to dig them out.

MR. VINCENT: I don't think you are troubled with fire, as we in the north are, in Copemish and towns of that kind. The wooden stakes only last until a man clears off his lot, and half of the time his lot is cleared by fire.

MR. HODGMAN: In our part of the state, the fire only burns the top of the stake off.

MR. VINCENT: Yes, but there are a good many stakes driven around, and every summer the fire burns off the top of them and the finding of one wooden stake isn't very satisfactory evidence to me. I am surprised that our Auditor-General takes plats without something beside wooden stakes. I have taken a great deal of pains. The last village I platted, it took

109 to mark the intersection of streets and alleys, and it took a great deal of iron, and I am glad to know that we can use wooden pegs; it simplifies matters. But by using iron stakes, if one is gone you can find the others, and I, myself, should be very loath to give them up. I find that up in the northern towns, after they get their lots cleared off, the wooden stakes are pretty scarce. They burn off and are raked off. It is different in cleared land, but I should insist on something more than wooden stakes in a village plat. For the corners of boundaries I have used gas pipe two feet long, or buried a beer bottle, or something of that kind, and I have found it a pretty good way to put a corner down deep, at least three feet down; make a post hole and let your plumb locate that nicely, and then take ordinary bricks and make a little pier to the surface. They will plow up two or three, but some will remain.

MR. STRONG: Speaking of a wooden stake, and its being a proper monument, I wish to say that I was up in the Auditor's office, and that the first two plats in the last book are from Detroit, and the monuments used were oak stakes, 1¼ inches in diameter. I asked the Auditor if such stakes would answer the purpose of the law, and he said the carrying out of this law depended upon the honesty of the surveyor. I said something further, about witnessing these monuments. I don't know as I ought to say it here, because many of us do not witness the monuments we ought to, and where we do, they are written down in the note books, and not on the plat. The law says that we shall monument all of these corners at the ends of the streets and alleys; it says furthermore, they shall be witnessed by permanent objects. The words are: "They shall be witnessed," but if you have witnessed them where is the place to show it, if not on that plat. Now it may be that 1¼ inch stake is a monument, and then maybe it is not. So far as I am concerned, I have no desire to put in a 1¼ inch stake, and certify to its being a monument, and I think we ought to carry out this law in respect to witnesses. The day is coming when there will be some men in this office that will say to these engineers, have you witnessed these monuments? "Yes, got it in my note book." Does that answer the purpose of the

law? We know better. Now it is time, if it is necessary to have our witnesses written in the plat, that we should know it, and begin early enough so we won't be dead and gone before a start is made.

MR. CHURCH: The difficulty in the way of the plan the gentleman has spoken of, is that most places where there are trees that can be marked as witnesses, they are usually soon cleared off. If it was an old place where you had the assurance that the trees would be left, I think it would be a very good plan, but I myself, have never surveyed a plat yet, where there was an assurance that a single tree would remain.

MR. BEAN: This question of monuments is a very essential one. There is a way of putting in wooden stakes that will answer very well. Take an ordinary stake, prepare your hole and fill it full of lime; then put in your stake and you have a pretty good monument. If they take the stake out, they will have to take out all of the lime at the bottom of the pit before they can destroy the position of that stake. Speaking about iron stakes, I notice that most of those here have mentioned gas pipe. If you are going to put in iron, cast iron is away ahead of wrought iron; cast iron water pipe has been laid for 100 years in New York city, and upon examination they could notice but very little depreciation in its value, but an ordinary gas pipe will rust out in a very short time.

Now, in regard to position of stakes—the centre or sides of the street. I have used both methods; another method I have adopted, is to put the stake out perhaps two feet from the corner intersection, and bore a hole six feet deep and put in lime or pulverized brick. If you put the stake at the corner, the first man that builds his fence will be very certain to dig that post out, and when you come around, he will tell you that the corner post is the exact point—he has taken pains to observe that point. But if you will set your monument in the street 18 inches, you will probably clear his post, and more especially if you fill the hole up with lime.

Another thing in regard to witnesses. Of course it is a hard matter to make witnesses of plats at the corners. If you had for instance, good permanent buildings, or where you were

taking measurements to the base of these walls, you would have something that would last. I would like the Society's opinion in regard to taking witness trees in the country. What is the preferable timber to use for witness trees? My experience has been, that a large hickory tree is the best, although when I was in the Government Survey, we were allowed to take anything except a hickory tree, even a poplar. True, the hickory is a short lived tree, but how about determining the position of that tree by a tap root. I have been surveying in Jackson county for a long time, and I think I have never failed in determining a corner to my satisfaction when I had a large hickory. When I examined my notes and found a good hickory for a witness, I found I could establish my corner.

MR. GOODALE: It seem to me if we place our monuments 18 inches or four feet from the block corner, that it is going to be right under the sidewalk. In my practice I have used the centre of the street mostly. I think by planting them well, they will be less disturbed there until the catch basins are put in.

MR. BEAN: I would say in connection with that—that would be where I would like to look for them. There are corners in Jackson which I would give $100 to locate. If I could locate them by taking up a block walk I would do it in a minute,

MR. DOANE: I have found the most satisfaction by securing the boundaries, and then I know where to go to work. I platted an 80 acres a few years ago and I got all of the boundaries. It was entirely covered by woods. I measured the boundaries very carefully, and then I knew exactly how far it would be across by computation, and then when I came to measure across by short lines, I found out if the measurement corresponded. In some places I put in iron stakes at the centre of intersection and others at the corners of the streets. I like to put them in at both places. Of course where you are in the woods, wooden stakes are very apt to to burn out, and you must have something that fire will not destroy, and still you usually find Government stakes that are not burned out,—if they are not decayed.

One objection to setting the post 18 inches or two feet from where it belongs, is that they are very apt to use that as a corner, unless you put the monument down as deep as Mr. Bean has suggested. I found such a case in surveying a section. It had been surveyed in 1877, re-surveyed, and they planted a corner two rods east of the true corner, for a witness corner and witnessed to that. The country was partly settled up at that time, and they went on and used that as the true corner; I was called to establish that corner a few days ago, and I found that in dividing it up, it brought that corner about two rods east of the point equi-distant, and it had been used probably for eighteen or twenty years as the true corner, there was a high-way built a mile north and south, and all the conveyances went to that corner, the gentlemen on the east was very anxious I should place that corner equi-distant between the section corners. I hardly felt as I wanted the responsibility of bringing on a law suit, so I told him I thought the true corner stone might be two rods west, and if he wanted to secure legal advice and go to law about it, I should not try to hinder him, butI shouldn't set the corner two rods west of there and pretend to say he could hold to it.

MR. BEAN: I would put these corners for permanent monuments only for blocks, two corners for each one, boring down about six feet, and these monuments I would put below the surface and leave a stake at the proper corner. If you could establish your block without any difficulty, there is no trouble then in making your lot corners; it is a little objectionable to have them under the sidewalk, but it is a pretty safe place.

MR. DOANE: In Gladwin, they have put their sidewalks all six feet from the street line, and left the space between for planting trees, and it makes a very pretty appearance, and would not disturb the monuments, although it makes the street a little narrow. That is the way their entire village sidewalks are laid out with the exception of the main streets; their sidewalks are six feet wide and on the main streets they are 12 feet wide.

MR. HUBBELL: I get the exterior boundaries and measure

them carefully; at those corners I put good monuments, and those corners I witness with trees if I can get them, and these witness trees I record on the plat. The interior work, I do not attempt to witness, this intersection of street corners. If I can find the outer lines, I can find the inside.

MR. VINCENT: Mr. Bean spoke of a hole, and filling it with lime. Now that may do very well in a clay country, where the hole will keep its form, but in our sandy country, and by the time the old surveyor had dug down two or three times, and the new surveyor five or six times, I think it would be very distracting.

MR. SKEELS: I think the best spot for a monument is right where it belongs. Find that place and put it there, whether under the sidewalk, in the centre of the street, or wherever it may be, and the best corner I have ever used or seen was to to take a post-auger, with a handle six feet long, and with it bore a hole; then take our common brick, and put one at the bottom and fill around it; lay another across and another on top of that, and fill in around them. In scraping or plowing, you disturb but one brick,—the others are there.

A party came into the office one day and wanted I should set some iron stakes at the corner of his lots. He would furnish the stakes. He said he wanted to put a nut on the upper end of the stake. I told him to put the nut so there would be 1½ inches of the stake through the nut, and put that end in the ground. He asked the reason, and I told him, and we set the corners in that way, and they have never been pulled up. Travelling through Richmond, Indiana, I noticed on the corner where the cement sidewalks were built, and within the stone flagging at the corner of the street was a stone about three inches square, with a cross in it. I noticed it and made up my mind it was the corner of the block. I travelled around a mile or so, and at each block corner, if it was a stone walk, there had been a hole cut through the stone, and that cross was there. If it was a cement walk, it was there; and if it was a board walk, that stone came up just flush with the walk, with that cross on. That was a good plan. Anything that we can get, and have it durable, will answer.

So long as the timber is standing it is all right, and it shows the disposition of the operator to do his work and do it well, if he uses them for witnesses, but it is of short duration. The proper thing is a good monument in the right place.

MR. HODGMAN: The brick plan is pretty good, so far as its durability is concerned. The failing is that it is not sufficiently definite, even if you have got a whole brick there. In the outset, where a few inches does not amount to much, that is all right, but if it is in the city of Grand Rapids or Detroit, we want measurements more definite than the brick. I think, practically, as Mr. Skeels said a year ago, this whole question is fully treated in my Manual. I have restored, in the past few years, something like 2,000 government corners, and have used, almost entirely, the monuments made by the Jackson Fire Clay Co. I bore a hole three or four feet deep and put one above another, packing around them with the best material I can get. These monuments have the advantage that they have a cross marked on the top of them, and you can locate the exact point as long as they stay there; and they have the advantage of the brick, in that, if the top gets knocked off, there are more below to mark the place. If there is anything more desirable, I should like to know it.

I think Mr. Bean is right about the hickory trees. I have had lots of experience in hunting witness trees and corners. I guess Mr. Bean and I have done more of that work than any other two men in Michigan. I find that white oak is pretty good, too. They have tap roots that give you a pointer to tell where to go for your stake.

MR. BEAN: One suggestion in reference to taking out a stake from a place where you have any lime. Now, there is the great trouble,—about 99 men in 100 do not know how to use a shovel around the corner. They will obliterate the whole thing in about five minutes. Now, supposing you have a hole here and put in two inches of lime, six feet deep. I would ask the gentlemen if it is necessary to dig all that out in order to know it is lime. Just the moment you come to the lime, that is all there is of it. You put a stone in the centre of a street or a country road, and the first man that is at work on

the road will hook a plow on it and pull it out, but the lime he will remove just the depth of the plowing. You can identify the corner, too, just as well, by following down where the stake has polished a way, as though the stake stood there, but if you go and take the ground up two or three feet deep, the game is up.

MR. HODGMAN: Now, if I were going to put in lime, I would use the best Portland cement. The lime itself is soluble in water, and dissolves in a short time—that is, common quick lime. If I were going to put it in, I would use a hydraulic lime, or any substance that is durable and can be put in in that way.

MR. APPLETON: When we came in, Mr. Chairman, they were talking about the proper place, the centre of the street, the corner of the block. Right in this town, to my knowledge, more monuments have been destroyed that were situated in the middle of the street, since the improvements have been going on there, than anywhere else you could speak of. Of course, if it is a section corner or something of that kind, there is the place for it, but if it simply marks an intersection or the corner of a block, it seems to me you could hardly set it in a poorer place than the centre of the street. Down in the lower end of this town there is one monument that governs the whole of North Lansing. I was City Engineer at the time and was very careful to preserve it. When we put a sewer down there, I measured very accurately and restored the place; I could not do otherwise, because the records called for a monument there, but there was quicksand where the sewer was put in, and the entire thing fell in, monument and all. The same thing happened again, and now I don't believe there is a man who can go and restore that monument within ten square feet. I found a piece of iron there, and notwithstanding I begged and prayed the contractor to let that monument alone, blessed if he didn't pull it out. I think the witnesses called for 90 links from the door of a blacksmith shop, and the blacksmith shop was burned down twenty years ago. Of course, it is all right enough to put things in the centre of the street, but, if you can, put them at the corner of the block.

MR. HODGMAN: It may not be out of place to describe the manner in which the monuments in Kalamazoo are located. A stone monument is placed at the centre intersection; in a little pit, and around that pit is an iron casting, I think it is a casting such as is used for a lamp hole, and then that is covered with a conical cast iron cover that comes up flush with the pavement. For some purposes, the simple cover answers,—if you want to be more exact, lift the cover. I think there is very little danger of any of these monuments ever being disturbed.

MR. APPLETON: There is a class of people that seem to delight in disturbing monuments.

MR. HODGMAN: I guess you cannot put in any monument that cannot be taken out, or that won't be taken out in some instances, but on the whole, I think the centre of the street is as little liable to be disturbed as any.

MR. SKEELS: So far as that is concerned, there is just as much liability to destroy a monument at the corner of a block as at the centre of the street. We that have been interested in excavations for buildings know this. You get your area wall out nine to fourteen feet from the corner of the block proper, and there is no way of perpetuating it only by the block itself, and you can't do it any other way, only to do it, and take care of it after it is done.

MR. HODGMAN: Referring to standards of measure, I think it is just exactly as Mr. Teed has said, there are a great many standards that are sent out; and all are guaranteed to be United States standards, yet they do not agree among themselves.

MR. ROGERS: It has been suggested that it would be a good thing if we had a standard in Lansing, then we could test them and have a uniform standard among ourselves.

MR. WILLIAMS: How many acres were there surveyed?

MR. TEED. About three hundred, part of it was included in the frame-work, but I have not charged for that yet.

MR. CHURCH: Can you put that on a plat in this state? The law says the paper must be 18 by 24 inches; can you get that on it?

MR. TEED: The bill sent in for the stakes was for 2250; there are over 1000 lots in the business there.

THE PRESIDENT: Mr. Church asks how you managed to get that plat on the paper of the size required by the statute?

MR. TEED: I did not put it on; in the first place, it is not done yet. The survey was made, but the plat is not finished; but when I finish, I will put on all the sheet holds, and put the rest on another sheet.

MR. ROGERS: I can answer Mr. Church's question; I had occasion to plat 800 acres into 500 lots, and the plat is in four parts, number 1, 2, 3, 4, and one sheet is given entirely to the description making five sheets in all; 15 pieces of paper in a set of three plats. That is on record now, here at the Auditor General's office. I also have another one of two pieces.

MR. SKEELS: There are certain cases where Auditor General's condemn that; the certificate has to be attached in certain cases.

MR. HODGMAN: In regard to the question of tapes, Mr. Mr. Rogers suggested that we might have a standard here at Lansing, and then all be alike. There is a difference in the quality of steel. A difference in the manufacture of steel causes a different rate of expansion in the different kinds of tape; and so two tapes might compare exactly at a certain temperature and when the temperature changed, the tapes would be different.

TOWNSHIP BURYING GROUNDS; PLATS AND RECORDS.

D. J. ALBERTSON.

Before I wrote my paper, I thought there was no question in regard to the statute, regarding plats, and I wrote to the Auditor General. He was of the opinion that cemetery plats came under the general plat law. That was news to me, and I took some pains to look the matter up. I consulted two different attorneys in the matter, and they did not agree with the Auditor General, but could not give a decided opinion. I went this afternoon and called on the Attorney General and thought perhaps I could get an opinion from him. He was very courteous and devoted some time to the consideration, but his duties were pressing, and he did not have time enough to devote to the question, but he was of the opinion that the law regarding cemetery plats and the general plat law were independent. He did not say that those which were made under the provision of the law in regard to cemetery plats would not be good, but he thought that the statute was deficient in some ways, and he thought that the diagram of the land and description ought to be more complete, so that the lots could be located without any question as to where they were. He suggested that it would be well to have the law amended so that the plat that was filed at the Register's office would be made of record, and a certified copy could be used in courts of record. He thought that cemetery plats, made under the general plat law, would be good, but he was inclined to the opinion that the fee of lands so transferred would be vested in the purchaser and not remain in the Board of Health. After this introduction I will read the paper:

Mr. President and Gentlemen:

It is not the object of this paper to offer anything strikingly original, or to revolutionize cemetery platting; but to simply present a few observations and plans that the writer has found adapted to the requirements of the work.

The time has come in many townships where the burying grounds located in an early day have become entirely occupied, and measures are necessary for their enlargement, or the location of new cemeteries. These old yards exist in all manner of form and condition. Many were never originally staked out; burials were made promiscuously, and so remain to this day; others, in years past, came under the supervision of officers with "progressive" ideas, who caused the trumpet to blow the resurrection signal for that particular yard, arranged the graves in rows, platted the ground with greater or less accuracy, perhaps terraced the lots and arranged things after the flower-bed style of architecture. Even at this late day, there seems to be little more system than in the past.

A brief digest of part of the law relating to township burying grounds may not be out of place:

"In every surveyed township, the board of health shall procure sufficient grounds for burial purposes, and their successors hold the fee of such land in trust for said township. They may sell or dispose of the same, or any part thereof, at any time until the same shall have been occupied, then only by order of court upon proper petition. In case of the division of a township, the cemetery belongs to that part in which it is stuated. The board shall make all regulations necessary for the government of the same, and shall give notice of such regulations by publishing the same in some newspaper, if there be one in the township; if not, by posting the same in five public places. They shall keep the grounds properly fenced, and all cost incurred for purchasing, fencing and regulating shall be certified by them to the township board, as part of the contingent expenses of the township. They may convey single or family burial lots in such township burying ground to such persons as may desire to procure the same, and use the proceeds towards improving the grounds, but must certify the amount of such sales and expenditures to the township board. *But*, before they can sell or convey any lots as above mentioned, they must cause the burying ground to be laid out in such form as they may choose, and cause two maps thereof to be made under the supervision and direction of the health officer and clerk, which shall be certified by them to be correct. One of said duplicate maps shall be filed in the office of the register of deeds of the county, and the other in office of the clerk of the board.

"Said maps shall describe the lands belonging to such bury-

ing ground, its boundaries and location. Also, show the lots or sub-divisions named, or numbered, with their size, situation and extent. Also, the width, extent and location of all streets, alleys or walks."

To this I would add: Plant permanent monuments at all angles and at all intersections of principal lines, walks or drives; and, if practicable, give angles at intersection. Mark *all* dimensions of irregular lots, blocks or pieces, and give enough dimensions on those of uniform size to leave no uncertainty as to their size. Draw the map to a true scale, give unit of same, and show the meridian. In fact, make the diagram of land and description to conform with those intended for city and village lots.

No rules or suggestions can be given as to the laying out. Each case must be governed by circumstances. Township burying grounds, usually, being square or rectangular, and in size varying from two to six hundred feet, afford but little opportunity for fancy styles. If an addition, many times the layout of the original part prevents systems that would otherwise be desirable.

In the matter of stakes, there seems to be a commendable inclination towards permanent stakes at lot corners. Wood stakes are unsightly and of short duration. Probably the best are the vitrified fire clay or terra cotta stake with the numbers stamped into the material while plastic. Cast-iron stakes are durable, but those having the cross section of an I beam, to facilitate painting the numbers on the front, are liable, in a short time, to present a zig-zag line, very unpleasant to the eye. A ⊢ cross section might obviate this. The smaller sizes of drain tile, with but a few inches projecting above the surface, are, I think, the cheapest and most permanent procurable. By setting every tenth one of a larger size, no numbering is necessary.

The law provides that "The board of health shall cause the grounds to be laid out," etc. A certificate, something like the following would seem necessary, and show that they had done so, by what authority, under what conditions, and that they approved of the proceedings.

"*Know all Men by these Presents:* That we, the undersigned, constituting the board of health [or majority of] of the Township of A——, have caused the land embraced in the annexed plat to be surveyed, laid out and platted, in accordance with section 1638, chapter 39 of Howell's Statutes, 3d volume, the same to be used as a township burying ground and known as_____. We hereby dedicate said ground for burial purposes, subject to the existing regulations and such others as may be made for the government of the same. We also accept and adopt said plat as hereon delineated.

[Signed officially.]

_____, *Supervisor,*
_____, *Township Clerk,*
_____, *Justice of the Peace,*
_____, *Justice of the Peace,*
Board of Health."

The law further provides that "The plat shall be made under the supervision and direction of the health officer and clerk," etc. The following certificate, or its equivalent, would therefore seem imperative:

"We, the undersigned, B—— C——, as health officer, and D—— E——, as township clerk of the township of A——, hereby certify that the plat hereon delineated has been prepared under our supervision and direction, and that the same is a true map of said burying ground.

_____, *Health Officer,*
_____, *Township Clerk.*

Dated this_____day of_____189__"

The law provides that duplicate maps shall be filed in the office of the register of deeds of the county, and township clerk's office, etc. Some certificate like the following, on each, would seem essential, and show that the other map had been filed as required.

"I hereby certify that a duplicate copy of this map of_____ as compared by me, has been filed in my office.

[*Signed*]_____"

A surveyor's certificate, something like the following, might be advisable, and show who made the survey, nature of permanent monuments, etc.:

"I hereby certify that the plat hereon delineated is a correct one, and that permanent monuments, consisting of (*State nature, size, material, etc.*), have been planted at points marked thus O, as hereon shown, at all angles in boundaries, and at all intersections of principal lines, walks or drives.

----------, *Surveyor.*"

It would be well to add, for the convenience of the recorders:

"Received and filed in my office at_____o'clock____M., this _____day of_____, 189__.

[*Signed by register of deeds or clerk.*]"

This closes the plat or record and location of lots, but affords no means of showing location of graves, or names of those interred. This is one of the most important parts of a cemetery record. It takes but a few short years for a grave to sink to the level of the surrounding surface. Quite recently a case came to the knowledge of the writer where a grave dug on supposed unoccupied territory unearthed the bones of a previous burial. There is, also, an inclination towards discarding raised mounds over the graves entirely.

One of the best records that has come to my knowledge is shown below, and comprises the desirable features of several records:

Burial Record of Evergreenwood Cemetery:

Date of Burial.			Full Name.	Male or Female.	Age.	No. of of Grave.	Place of Death.	Disease or Cause.	No. of Lot.	Remarks.
Mo.	Da.	Yr.								

In the column "No. of Grave" is inserted the number consecutive with the digging, reference being had to a diagram of the lot, not drawn to scale, for their relative positions, thus:

	3	1		2	4

or by dividing each lot into sections of an arbitrary size, and numbering them consecutively, thus:

1	2	3	4
8	7	6	5

giving to each grave the number of its section. This I would amend by giving to each grave the number corresponding to the number of feet the center line of grave was from a certain uniform point on each lot, as the right hand front corner, designating front and back tiers on square lots. The above meets most requirements of a *burial* record, but nothing further.

The following I have designed as embracing nearly everything required by way of reference or record.

EAST COOPER CEMETERY.

LOT No.----------

Conveyed to----------

Date----------

by----------

----------*Sexton.*

Heir's burial privileges acquired by

----------*heir of*----------

by----------.

----------*Sexton.*

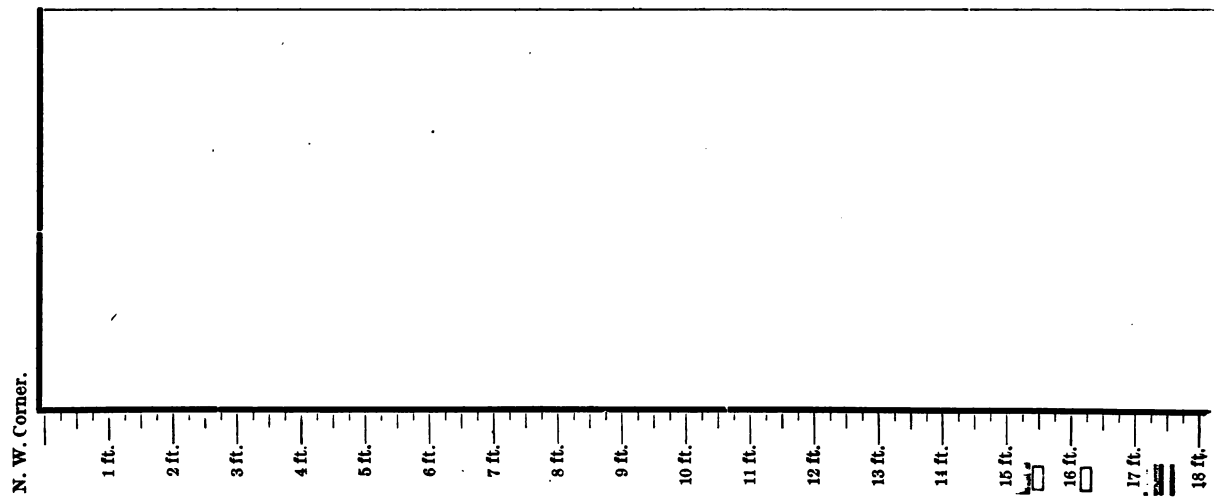
----------*heir of*----------

by----------.

----------*Sexton.*

I hereby surrender to the township the unused----------*of Lot No.*---

For further record of this Lot see----



The blank represents one page of the record book as it leaves the bindery, and space for the record of one lot. The size of page being variable, to correspond with the size and shape of lots.

The first column should show the number of lot; name of person whom it is "conveyed to;" "date title was acquired;" how it was acquired, whether "by certificate from board of health," "stipulation with sexton," or otherwise, followed by signature of sexton.

After the death of the owner, the second column would show in whom the privileges become vested, and how; whether "as legatee," by "stipulation among heirs," "only heir," etc., followed by signature of sexton, cognizant of facts.

The third column shows in case an owner had used only a part of a lot, and by reason of removal, or other cause, wishes to return to the township the unused part, he could do so by filling out and signing the blank given; though, in some cases, it might be advisable to have a more formal document additional. The second blank could show where record of any surrendered part would be found. Where any certificate or deed was recorded. Where any record of action of board of health regarding lot, would be found, etc.

The scale marks the front of the diagram of a lot, the O being some uniform point on all lots. The co-ordinates of each of which if practicable, should be given. The remaining lines of lot need not be drawn to scale, but exaggerated, to give room for names. The dimensions might well be marked on them. Supposing a grave to be dug at some point on a lot designated by the owner. Measure on the ground along the front of the lot the distance from O (in this case the N. W. corner) to the center line of the grave. At the corresponding distance on scale at front of lot, on record page right across the lot, name of person buried, age and date of burial. When a monument is erected, it can be designated by a □ at head of grave.

There is also connected with the book two indexes; the first, containing the names of lot owners, and number of their respective lots. The second (large) the names of all persons

buried, year buried, number of lot on which they are buried and remarks, thus:

YEAR BURIED.	FULL NAME.	NO. OF LOT.	REMARKS.

The column "year buried" will be found very convenient for sextons in making out returns of burials each year.

Then, if we know the name of a person previously buried, by referring to the index of burials, the number of the lot will be shown; by turning to the lot, the scale at front locates at a glance the exact position on the lot, while the plat will locate the lot.

It would be well also, to have blank record pages in the book for entering the regulations governing the yard and the amendments thereto. Also that the sexton be provided with copy of the plat.

It would be desirable to have two copies of the record books; one in the sexton's office, and one in the township clerk's office, the same to be posted once each year, to prevent loss of records by fire or other cause.

THE PRESIDENT: The gentleman has presented this grave subject very fully. The system of record is about as good as anything I have ever seen.

MR. APPLETON: It is just what is used in this city. It was an old sexton who originated it. We staked out the cemetery. He, caring for it so long, had found out just about what was wanted.

THE PRESIDENT: I should think it would be still more necessary under the system of modern cemeteries, where, as soon as possible, they level the graves down and cover them over with sod, so that the whole surface of the cemetery is a smooth surface.

MR. APPLETON: That is not done here, but it adds very much to the appearance.

REPORT OF SPECIAL COMMITTEE ON STATE BOUNDARY.

To the Michigan Engineering Society:

Your committee would respectfully report:—

This society has more than once had evidence to show conclusively that our surveyors along the southern boundary of the state have difficulty in establishing this line, or leave it unmarked. This arises from its complications as a state boundary, and also from its extinguishment. The meager field notes and poor plats, which your committee has carefully gone over, give no more certain and permanent monuments across from Lake Erie to Lake Michigan than witness trees, some being aspen, birch and maple, none better than the section lines in any part of the state.

The line adopted was run by Wm. Harris in 1817, and, along the state of Indiana, was retraced in 1827 by E. P. Kendricks. I quote from his notes to show the character of the monuments:

"October, 1827. Commenced at the southern extremity of Lake Michigan, at a corner established by Mr. Harris in June, 1817, which has its bearings as follows: An aspen 9 S, 56° W, 200 lks. and an aspen 12 S, 42° E, 184 lks. The post which was set by Mr. Harris was entirely covered by the sand. I traced his line east to his 1st and 2d mile corners and found them correct. I then traversed the margin of the lake to get 10 miles northing (here the courses and distances are inserted) which brings me 32 lks. too far north. Thence south 32 lks. on beach to commencement of the line between Indiana and Michigan. The lake coast, so far as I traversed, is a continual chain of hills formed of beautiful white sand, in most places very high, and little or no vegetation. Back of these sand hills it is generally swamp and marsh, therefore there are but few places that the lake can be approached without difficulty and no harbors or islands are to be seen. From commencement of low water mark, ran east 250 ch. to a pine 10 in. in

diameter, on top of first bank, which I marked, on north side, M. L., and on the south side I. L., from which," etc., etc.

These are specimens of the monumenting of our state boundary. No wonder, then, that citizens of one state claim to reside in the other when the tax-gatherer comes, and that criminals raise the question of jurisdiction. No wonder that highways, school districts and farm lines have become uncertain. I might also say that the Ohio boundary, although retraced by Mullett as late as 1842, is no better monumented, and that our sister state is giving the subject attention.

The Michigan legislature of 1889, by concurrent resolution No. 10:

Resolved by the Senate (the House concurring), That the secretary of the Interior be and he is hereby requested to cause a survey of the boundary line between the state of Michigan and the state of Ohio, and between the state of Michigan and the state of Indiana, to be made, and to make such arrangements for the preservation of the monuments of such survey as will secure the endurance of the same for the future.

And further resolved, That a duly certified copy of this resolution be transmitted by mail to the secretary of the interior by the governor of the state at the earliest possible moment.

Whether this urgent appeal to the secretary of the interior has caused that official to start out with his compass and Jacob's staff, your committee has not learned. It is a beginning.

In our opinion this case does not need the intervention of congress. The states interested are abundantly prepared to act; only put them into step. It does not call for fine-haired surveys on thirty-second instruments. It is a case where good, keen-eyed, level-headed engineers shall go out and take evidence of what they find and make a note of it with a proper report, and then be authorized to fix that evidence both of record and upon the ground for the many years to come.

In 1878 the state of Ohio passed an act of a similar intent.

"Be it enacted," etc., "That, as soon as practicable after the passage of this act it shall be the duty of the governor to appoint three competent persons to be commissioned to act

in conjunction with a similar commission of the state of Pennsylvania (but not otherwise) to examine as to the true location of the monuments which make the boundary line between the state of Ohio and the state of Pennsylvania, and, in connection with the said commission of the said state of Pennsylvania to replace any monuments that have been removed, or that have become displaced or dilapidated on the boundary line of said states. Said commission shall report to the governor an account of all expenditures arising under this act, together with a full report of their proceedings, accompanied by such maps and draughts as may be necessary to a clear understanding of the same, and the governor shall report the same at the first meeting of the general assembly thereafter." Severe penalties were enacted for the disturbance of the monuments set by the commission.

Then, in 1879, an act was passed to give the commissioners authority to erect these monuments. Also, in 1883, a joint resolution was adopted referring to the work done by the commission, as a resurvey and a remarking of the boundary.

"*Therefore, resolved,*" *etc.*, "That said boundary line, as marked by said commission and set forth in their report, field notes and map, is hereby accepted by the state of Ohio as the true boundary line between the state of Ohio and the state of Pennsylvania, the auditor to carefully preserve the report of the commission, field notes, maps, etc."

This brings us to the same conclusion as heretofore, namely: If this plan was good enough for Ohio and Pennsylvania, it is good enough for Michigan and the states bordering, and should be carried out as soon as may be. It is a mortifying admission that our own state land office is not furnished with better data of this boundary. A few torn plats and copies of abbreviated notes, referring to perishable witnesses, is the outfit. Your committee considers it important that this society, which is well qualified to know the facts, should ask our legislature to take immediate action on this question, and invite our sister states to co-operate with us.

Respectfully,

GEO. E. STEELE, *Chairman.*

THE PRESIDENT: What shall we do with this report?

MR. HODGMAN: I move that the report be accepted, Motion seconded and sustained. Report accepted.

MR. HODGMAN: I would further move that the committee be requested to prepare a suitable memorial to the legislature, to be presented in the name of this society, to report sometime during the meeting of the present convention. Motion supported and carried.

MR. HODGMAN: Some one of our members at a former meeting, I think it was Mr. H. C. Pearsons, at any rate, someone familiar with the work of retracing the line between Ohio and Pennsylvania made the statement that in retracing that line, the best preserved monuments they had were wooden stakes. The stakes outlasted the stone monuments that had been built with great care.

The following memorial was prepared by the committee and approved by the society:

MEMORIAL.

To the Honorable, the Legislature of the State of Michigan:

Your petitioners are members of the Michigan Engineering Society and would respectfully represent:

That, we have, through a committee appointed two years ago, made investigations as to the condition of the *State boundary* between the states of Michigan and Ohio, and the states of Michigan and Indiana, a report of which committee is subjoined.

In view of the importance of the subject, in the settlement of the various questions constantly arising, and of the proper perpetuation of these boundary lines, we would ask that immediate attention be given to the subject by the enactment of a bill, by which the Governor will be authorized to appoint a commission of three members, to co-operate with a similar commission from each of the states interested. First, to

report on the exact condition of said lines; and second, to properly perpetuate them.

E. W. Muenscher,
D. Skeels,
Wm. Appleton,
Wm. B. Sears,
H. F. Bean,
F. H. Williams,
A. L. Marhoff,
E. W. Redman,
F. F. Rogers,
Wm. G. Fargo,
Dan. J. Albertson,
John J. Granville,
Geo. W. Doane,
O. C. Goodale,
M. H. Bailey, Eaton Co.
Sam'l E. Jones,
H. L. Thayer,
H. E. Riggs,
A. J. Teed,
E. O. Sellers,
F. Hodgman,
Geo. E. Steele,
Frederic L. Church.

ADDRESS OF MAYOR BEMENT.

Mr. President, and Civil Engineers of Michigan:

One of the pleasing and innocent occupations of the Mayor of this city is to welcome to its borders various bodies of men who come here to hold their annual meetings, and I assure you it is a great pleasure to welcome you here to-day.

Now it is customary on an occasion of this kind to remark, and I will say that I have made this same remark a number of times, that you are certainly a fine looking body of men. It is not necessary for me to say that I am highly pleased with your appearance.

I think perhaps that I may have a slight conception of what is expected to-day of a Civil Engineer in Michigan. I only have a slight conception, but I have wished a good many times, since occupying my present position, that the Civil Engineers of Michigan, and particularly those of Lansing, might have had at least one hundred years experience. The building of a city I do not know very much about, but I do know that beginnings and small things oftentimes do grow into large things, and the desirability that somebody should know at

the beginning what they are going to grow into. If that were possible, I know that we should have saved a great many mistakes, and a great deal of useless expenditure of money. I have sometimes thought that even in the smallest villages if they should employ a competent civil engineer, when it was simply a village, and should pay that man a good salary, that the amount he might be able to save to that village corporation would more than compensate for the salary.

How much more is this true of our larger cities. How much more it is true that a man who is taking charge of the work of building a city, should be thoroughly equipped for his work. Most people have to be trained to their occupations, and I can readily see what a task you all have before you in equipping yourselves for the work which you are expected to do.

Therefore gentlemen, I take especial pleasure to-day, in welcoming you to Lansing, and saying to you that I believe that not only our city government, but that our citizens generally appreciate the position you occupy in the industrial progress of the country in laying out our cities, in making them beautiful, in furnishing them with good sewerage and good streets, and all those things which go to make up a fine city, of which I think no state has more, than our beloved Michigan, and I have no doubt that it is very much owing to your efforts that such is the case to-day.

I therefore say to you, gentlemen, you are welcome to Lansing, and I take pleasure in handing you the keys of the city and saying "come in and take possession of it."

THE PRESIDENT: In behalf of the society, I beg to return our thanks for your cordial greeting. I am only sorry that the engineers are never speakers. But perhaps the best reply I can make to your welcome is to assure you that it will not be necessary to increase your police force on our account, while we are present with you.

GOOD ROADS.

BY E. W. MUENSCHER.

[Chief Engineer M. & G. R. Railroad.]

In opening the discussion of the subject of "good roads," I think I can truthfully say that there has never been a time in the history of this country when there was so general and deep an interest in this subject as there is to-day. Much of this interest is due to the efforts of the League of American Wheelmen, whose publications have been widely circulated, and have been instrumental in diffusing much information among the masses of the people. They have also been the means of awakening the interest of the press of the country, and we engineers and surveyors are now receiving a large amount of gratuitous instruction in the art of road building from the omniscient editor. It is presumably intended for others less fortunate than ourselves, but there is no law which forbids us too from drinking at this perennial fountain of wisdom, and often perhaps with profit.

But the American people are apt to run to extremes, and while there is much that is being written and said that is wise and just and timely, there is also much that is unreasonable in the complaints and criticisms which we sometimes hear from the more zealous advocates of road improvement. While we are free to admit that the roads of the state of Michigan are far from being what they ought to be for the best interest of the state, and that it would be difficult to exaggerate the wretchedness of their condition at some seasons of the year, we should not forget that the state is not yet 55 years of age, and that over a large part of her territory still waves the primitive forest. Her first settlers were poor men who came with but little capital beyond their stout hearts and willing hands, to subdue an unbroken wilderness. Their lives were spent in the hard toil of clearing off the timber, pulling out the stumps and breaking up the virgin soil. They had no time, nor means to devote to road-making, beyond the simple wagon track over

which they hauled their scanty crops to the nearest market. The accumulated fruits of their toil, and that of their children, have been absorbed in the construction of homes and out-buildings and fences, and churches and school-houses. These were the prime necessities of a civilized and christian people, and until they were provided other things which seemed to be less essential were obliged to wait their turn.

It has been a work of years, and while it was going on but little could be done in the way of road construction beyond what absolute necessity required. Over the greater part of the state this work is still going on, or is not yet begun, and yet we are reproached because our roads, built as they have been solely by voluntary contributions from the hard earned savings of a free people, do not always compare favorably with those of Europe, which have been the gradual growth of centuries of civilization, and too often the product of enforced or enslaved labor.

Twenty-two hundred years ago the Romans were building roads almost as solid and enduring as the eternal hills from which the rock was taken to pave them. Eighteen centuries ago Pliny was writing specifications for road construction, which would not be bad at the present day, and which read marvellously like the strictly original productions of some of our modern engineers. Nine centuries ago the wandering follower of the Prophet could travel ten miles in a straight line along the paved streets of the Moorish city of Cordova by the light of street lamps. The paving of the streets of Paris was commenced 700 years ago, and of London but little later. The most ancient of these works survived for use and example and instruction, even through the ages of darkness and ignorance, and superstition, mud and filth that spread like a pall over Europe, and since the invention of printing, and the dawning light of religious freedom began to lift the cloud, more than 350 years have elapsed, (seven times the life-time of the state of Michigan,) through which inch by inch could be added to the relics of long past industry and wisdom. Give Michigan three centuries more of life, and she will show you roads all over her vast territory, over which even a Roman Censor or a Saracen Caliph need not scorn to ride.

But, however reasonable this excuse may be for past deficiencies, and however justly it may still be urged for a large portion of our state, there are many other portions to which it will no longer apply. There are whole counties in the southern part of the state, and many townships and neighborhoods elsewhere, in which the laborious pioneer work of clearing off the forests is largely completed, churches and school houses are provided, surplus capital is beginning to accumulate, and the time has come when it is possible, in these sections at least, to begin the work of building good roads.

What, then, is required to start the good work? The reply is: 1st, Education; 2d, Legislation; 3d, Action. Many of us perhaps would like to skip over the first two stages and begin with the third. In a despotism this would be possible, but under a popular government like ours, never.

Roads cannot be built without money; money cannot be raised without taxation; taxation cannot be levied without legislation; and no legislation could be of any permanent avail unless demanded and sustained by public sentiment. To create this sentiment is the first necessity of the hour. The people of the state must be convinced, 1st, that improved roads are good things and, 2d, that they can afford to put their hands in their pockets to pay for them. So far as the first of these two points is concerned, but little remains to be done. There is not one man in ten in the state of Michigan who does not know that good roads would be a blessing to himself and the whole community. We read a great deal just now about the necessity of educating the farmer, but, as I believe, without good reason. The farmers of Michigan are, as a general thing, an intelligent and wide-awake set of men. Though, as a class, they may not be able to figure out, in dollars and cents, the precise annual loss which they sustain by reason of bad roads, or to apply the most efficient remedy, they are generally very thoroughly convinced that good ones would be a great boon to them. Indeed, I am inclined to think that no class of men is more fully aroused to the necessity of road improvement than the farmers. They know that first-class roads mean to them the ability to go to market at

any time in the year; to take advantage of the best prices and the best markets, and to put the difference in their pockets; to haul double the load in half the time, and thus save a large amount of labor and time, to be applied, with profit, to their farms; to get along with fewer horses and save in purchase price and cost of keeping; to introduce a more varied and profitable husbandry by cultivating garden truck and other perishable produce instead of the low-priced grains to which they are now confined. They know, too, what is of even greater consequence than mere pecuniary profit,—that good solid roads mean the breaking of the blockade of mud which now shuts them and their families up in their houses during much of the year. They mean the ability to attend their churches and farmers' clubs and social gatherings, or to visit a neighbor, or to go to town to a concert or lecture whenever they feel like it. They mean daily mails and free delivery, and larger school districts, and better teachers, and better graded schools, from which their children will not be kept away one-fourth of the time by the depth of the mud. They mean all those intellectual and social enjoyments, the absence of which is the crowning evil of rural life, and, more than anything else, is driving so many of the farmer's sons and daughters to the cities, and so many of their wives to the asylum or the grave.

Why, then, do we not have good roads? Mainly because the farmers know that, under our present road system, the entire cost of these roads would fall upon them, and it is a burden which they are neither able nor willing to bear. The wheelmen, the merchants, the residents of cities, the railroad companies, would all share largely in the benefits of good roads, but would contribute nothing toward paying for them. Until this obstacle is removed we need not look for improved roads, and all our arguments and demonstrations will be in vain. This can only be done by legislation, and it is to our own state legislature that we in Michigan must look for relief.

It is true that some are advocating the adoption of a general system of road improvement by the general government, and it has even been proposed to create a new department with a cabinet minister and a few score of clerks to tell

us how to build a road, but it is not at all likely that any such project will succeed. The general government is likely to have its hands full for years to come in discharging its own legitimate functions without assuming those of the states, and if it will only keep our rivers and harbors in shape to accommodate our commerce, we ought to be content.

The commissioners appointed by Gov. Winans to investigate this subject have reported that, under the provisions of our state constitution, the necessary legislation cannot be obtained, but this need not discourage us from considering what this legislation ought to be, for there should be no doubt that, in the present condition of public opinion, our legislature will promptly submit, and the people as promptly ratify, any necessary amendment.

As to the details of the required legislation, there will be much difference of opinion and much need of wise counsels. Especially will it be necessary to avoid running into extremes, either as to the amount of work to be done or the material to be employed. Great as is the evil of bad roads, that of excessive taxation or of crushing debt might be still greater. Whatever is done must be limited by the ability of the people of the state to pay for it without distress. Upon one point there will doubtless be a very general agreement, and that is that the present system, both of raising and expending the road funds of the state, should be abandoned. One of our most intelligent farmers, in an article in the *Grange Visitor*, of December 1, 1892, which is well worth reading, estimates the the total amount raised annually in the state for road purposes at a little more than $2,000,000 in money or its equivalent, and that not less than half of this sum is wasted on the wages of useless officials and on inefficient, misapplied and misdirected labor. All of us who have ever seen the average highway commissioner and his neighbors working out their road tax by scraping the sods and silt from the sides of the road into the center, or have ever had occasion to examine the average highway bridge, will readily agree that this estimate is not far out of the way. But, even if the entire amount were wisely expended, it would be far below what is necessary. Accord-

ing to the 11th census the land area of the state of Michigan is 57,430 square miles, or about 1,600 ordinary townships six miles square. This would give each township, on an average, $1,250 a year. Deducting the necessary cost of repairs, superintendence and administration, there would not be enough left to build half a mile of reasonably good road. The first mile built would be worn out long before the last one was begun. We must certainly have more money, but how to raise it without imposing too heavy a burden upon the people will be the most difficult question for the legislature to answer. It concerns us rather as citizens and taxpayers than as engineers, but it must be answered satisfactorily before the engineering question can come up at all.

It will not be far out of the way to assume that in each ordinary township there is now, or will be eventually, about seventy-five miles of highway. Estimating the average cost of a good gravel or other improved road at $2,000 per mile, the entire cost to the township would be $150,000, or about $6.50 for each acre of land in the township, and $520 for each 80-acre farm. It is safe to say that there is not a township in the state that either would or could attempt to raise this amount in a single year, or even a short term of years. It would be equally unwise for any township to load itself with such a burden of debt for the purpose of completing the work at once. It is plain that the work of construction should be spread over a series of years, and the work of payment over a still longer period. All the benefits of good roads will descend to our posterity, and there would be no injustice in asking them to pay part of the cost. Suppose each well-settled township should undertake to build its system of roads in, say, ten years, beginning with those running each way from its railroad station or principal market town, and pay for the same partly by an annual road tax, somewhat larger than the present one, and all paid in cash, and partly by bonds running from ten to thirty years, so divided that the payments each year should be approximately equal. The burden would thus be distributed over forty years, and would not be severely felt, while the benefits would be realized within a very reasonable time.

It might be advisable to assess part of the cost of each road upon the district immediately benefited, as is now done in some states, and is very common in our Michigan cities in the case of street improvements. But, even if this policy should be adopted, a part of the amount should be raised by general tax upon all the property of the township or county, so that all who are to enjoy the benefits may help to bear the burden. How far the state at large may share in this work, beyond providing the necessary legislation is a disputed and delicate question. My own judgment is, that in view of the unsavory odor of fraud and favoritism and extravagance, which has attached to most of the past efforts of the state to carry on internal improvements, it would be the wisest policy for her to keep her hands off entirely. She should, however, guard against unwise parsimony on the part of local authorities by prescribing standards of construction, to which all improved roads must conform, just as she now does in the case of toll-roads. She might also very properly aid the work by the carefully guarded loan of her credit. Our state is practically out of debt, her credit is very high, and her indorsement upon county or township bonds issued in judicious amounts for road construction would enable them to be sold readily at par, at low rates of interest. The burden upon the people would thus be largely diminished, while the state, being only an indorser and having the supreme power of taxation for the security, would be perfectly safe.

She could also aid indirectly by legislation, encouraging the use of wagon tires wide enough to pack down an improved road after it is built, instead of cutting it into ruts, as is now common.

But whatever means may be employed for raising money for the construction of a system of improved roads, success cannot be expected, unless the work is done under the supervision of competent men. And here there will be need of much caution. The fact that a man has received a majority of the votes in a county for the office of county surveyor, in a heated political contest, in which all personal qualities are often lost sight of in the struggle of two great parties for

supremacy, is no criterion at all of his fitness for this duty. Under our present laws, there is nothing to prevent a man from being so elected, who does not know the difference between the jacob-staff and the needle of his compass, and even if he were most thoroughly qualified for the ordinary duties of a county surveyor, it does not at all follow that he would be a competent road builder. A man may be an excellent land surveyor and yet know little or nothing of road making, or any other branch of engineering construction. For this reason it would be very unwise for the legislature to attach the duties of a road superintendent to the office of county surveyor by force of law. At the same time his public and official position, his presumed knowledge of the use of instruments, and his affiliation with the political party in control in his county, would naturally commend him for appointment to the charge of the road work of the county if he possessed the other necessary qualifications, and this fact should be an inducement to those who now fill that office to acquire those qualifications, and might possibly lead in the future to bringing a higher order of talent and acquirements into an office which now has but few attractions, and very generally goes begging. What these qualifications should be, and how they should be tested, it must be the duty of the legislature to prescribe, and the best interests of the people of the state require that the duty should be carefully performed. If no test at all should be required, the probabilities are, that in very many localities, motives of economy or of personal or political favor would lead to the appointment of men poorly if at all qualified for the work. Some test should be essential, and I know of none better than the certificate of a competent and honest Board of Examiners, and that board might well be composed ex-officio of the professors of engineering and surveying in our State University and Agricultural College. They are men who have been appointed to their positions by reason of their high attainments in the branches of knowledge with which a superintendent of roads should be familiar; they are specially qualified by their long experience as teachers for finding out just what a man really knows; they are happily free from the restraints

and prejudices and temptations which might affect the action of a local or political board, and their being already in the employ of the state would considerably diminish the cost of their work.

In many of our counties there would be no difficulty in finding more than one man who either is already qualified or could easily make himself so by the study of the many excellent treatises on road making which are now in the market, but in others, it might be more difficult to find material, and for their benefit it would be policy for the state to provide a special course of instruction in road location and construction in the University or Agricultural College, or both, during the winter months when those for whose benefit it is intended could most readily attend. The only expense would be for the necessary additional instructors.

If in addition to this provision the state would publish in cheap form, and distribute to all the supervisors and county officials of the state a compact treatise on the construction, improvement, care and repair of common roads, including those of gravel and broken stone, together with approved general specifications, it would be of really more interest and value to the people of the state than a majority of the reports which it now issues.

It is not my intention on this occasion to say anything on the engineering features of this subject. I hope to hear this better done by others. I will venture, however, to touch briefly on one other point in which many members of this society may well take an interest. No interest in the state of Michigan would be more benefited by good roads than the railroads. During a large part of the year much of their rolling stock is lying idle because farmers cannot bring their produce to the station. At other times they cannot get cars enough to haul away this produce, and sidings and elevators and warehouses are gorged to overflowing; extra train forces must be employed; men in other lines of traffic who need cars are denied, and general disturbance of business, delay and loss follow. Good roads would distribute this business more uniformly over the year, to the mutual advantage of the com-

panies and their patrons, to say nothing of the increase of population and production and prosperity which would follow. These railroad companies are usually very earnest advocates of good roads, but, under the laws of this state, they do not contribute one dollar toward their construction. This is an injustice which ought to be remedied if possible, but, whether it ever is or not, there is one way in which the railroads might greatly help on and hasten the good work without cost to themselves. If we are ever to have anything better than dirt roads in Michigan, we have got to depend almost entirely upon gravel. This material is found in vast quantities in the drift which covers the entire lower peninsula, but the deposits are local, and there are large sections in which a stone as large as a hazel-nut would be a curiosity. The cost of hauling gravel to such localities is so great as to forbid its use. It is here that the railroads could do a good work. Most of them pass through or near large gravel beds. If, at times, when many of their flat cars are lying idle, they would load them with gravel and deliver it at each station along their lines at bare cost, to be used in building gravel roads each way from those stations, they would greatly diminish this most serious obstacle. Some of them also own steam excavators, which, at times, could be used in loading the cars, with a further saving in cost; and other roads might well afford to purchase these excavators for this purpose. It might even be policy for each road to keep on hand a few miles of light rails and ties to be laid down temporarily along these highways, over which the gravel cars could be hauled, and unloaded by machinery, with another considerable saving. This idea is not a new one, for it has been put into practice, to some extent, by some of the roads in Indiana and Illinois, with good results to themselves and the country through which they run. The roads of Michigan might well follow the example, and if the members of this society who are connected with them would use their influence with their superior officers, to induce them to try the experiment, they might accomplish much toward hastening the day to which we all hopefully look forward.

EAST PARIS, January 17, 1893.

E. W. Muenscher, President Michigan Engineering Society:

DEAR SIR: I regret that I have been unable to prepare a paper on the subject of roads, as requested, for your meeting. What the farmer wants now is laws that will compel all property and all people to pay its and their full share of the expense in making good roads, and a knowledge of the probable cost of such roads. The farmers have given all the land for the public roads, and, since the settlement of the country, have paid all the taxes for road improvement. The public have had the use of the roads, and only part of the public—the farmers—have borne any of the burden of making them. There has been no law by which they could avail themselves of the skill of the engineer or surveyor, consequently all roads have been made by guess. One-half the labor and money expended for the last fifty years, had it been expended under the direction of competent engineers, would have given us infinitely better roads than we have to-day, and the foundation would have been laid for much better roads than we can now make, unless at greater expense than if we had started right. Without the aid of the engineer we never need look for good roads. Men do not build houses or public buildings without first consulting the carpenter or architect, nor do they engage in an important lawsuit without consulting a competent lawyer. I would suggest that your meeting give to the public an estimate of the probable cost of good roads, to be built by contract, under the superintendence of proper commissioners and engineers. A first-class road is better than our present "toll road." It is not expected that we will at once enter upon a system of road improvement and make finished roads equal to those in the "Old Country," but we can make a good beginning, and, in time, make complete finish. Your members, coming from all parts of the state, will have some knowledge of the available material for making the roads. Give an estimate of the cost of preparing stone by machinery, for stone roads; the amount required for the

ordinary travelled roads; the cost of a stone road as compared with gravel roads, where the material of the one is as accessible as the other; the cost per cubic yard of crushing the stone found commonly on the farms of the state; the thickness of stone required for a stone road, and the thickness of gravel for a gravel road. The farmer wants good roads and must have them before he can enjoy rural life as he should. When we get good roads we shall get free delivery of our mails. Good roads and the free delivery of our mails will both come at the same time. When we get both, farm property will have greater value, and rural life will be more attractive and enjoyable. I think the more intelligent public, if not all the people, will give thanks for whatever information and advice your intelligent body of engineers may see fit to give. Prejudice will exist for a time, but will soon give way under the second sober thought of the people. I shall look for good results from your meeting. Truly yours,

S. S. BAILEY.

IMPROVEMENT OF COMMON HIGHWAYS.

BY R. C. CARPENTER. ITHACA, N. Y.

As many members of the society no doubt remember, the writer has discussed the question of Road Improvement, by lectures, and by articles which have been published in the Reports of the state Board of Agriculture. The effect produced by these articles have seemed quite insignificant, and a more extended experience has led me to believe that the question of road improvement is to be first discussed as a social and political question, rather than as an engineering one. There is little use in giving information regarding the construction of roads, unless a desire can first be kindled for better roads. The people should be taught that better roads will pay, that it is poor economy to waste time and animal power in dragging light loads over muddy roads. If they can see that good roads pay, then they may be induced to build good roads. The present movement is the first that has been

started that has had any chance of success, and this is due to the fact that the movement has been conducted in a manner to appeal to the pride and interests of the people. It is the duty of every engineer to press onward with enthusiam and urge in every possible manner the success of the movement. This should be done from the standpoint of the citizen, and not from that of the man who sees in the success of the proposed movement, a job in the distant horizon. Indeed, such advocacy will imperil the success.

When the people have been led to the idea of road improvement, then will they listen to technical methods and plans of securing such improvement. To-day the question is more of a political one, and the attention should be given principally to the ways and means of securing public interest and public attention.

While it is certain that there is no public investment that will return so much to the rural population as that put into road investment, still the fact must be faced, "that good roads will cost money," and the people are not accustomed to put good money on the roads.

You will find also that in your state the wheels of progress are blocked to a great extent by your existing road laws.

I do not refer here to the system of paying the road tax in labor, which has so long prevailed in nearly every portion of the country, but I do refer to the senseless method of dividing up townships into districts for road improvement. The payment of the road tax in labor, is in my opinion, not the bar to improvement that so many have claimed, and considering the small amount annually expended, I believe as much has been accomplished as could have been done with cash. It is true that the labor has often been badly directed, and the improvement which resulted of a negative character, but I think no one believes that the same talent that so lavishly wasted and misdirected labor would have done any better with money. The remedy is not to be sought primarily in a money tax; no tax can be used to benefit the highways, until the law permits a combination, of all the parties interested in road improvement of a partial highway. The present system divides the country in sections of small extent, with some main road, and

a great deal of back road. It often happens that the men who work the road and pay for the improvements, rarely travel over it, and have no personal interest in the road at all. Again the system does not admit of different trial improvements, each land owner secures about the same expenditure to the road adjoining his premises, whether the road is of importance or not. The expenditure of the labor or money with such a system is attended with diffculties which will surely defeat the object sought.

A township district, since it is larger, might in some respects, be an improvement, but even here we should find a want of interest, or perhaps a clashing of interests that would defeat the best laid plans. The true road district is one formed on natural laws, and by a community of interest of those who use a given highway, and is made regardless of township or even county lines.

It is no doubt practicable to provide that a certain district interested in the improvement of a given highway can combine, and organize to improve that highway by taxation of all the property benefited. Such a law would result in the construction of trunk line roads leading in various ways from the principal market towns, which would in this way afford with moderate cost, the benefit sought in the proposed improvement.

It would also result in the construction of cross roads or by-roads, branching at intervals, as the people require, from the more substantial and better built main roads. The latter system could be organized as independent of the present system, and a money tax could be raised for the principal highway, which in such a case should be released from the supervision of the present authorties.

The above system is urged because the writer believes, first, that it is practicable; secondly, that it will impose less hardship upon those who are interested; thirdly, that it will result in producing the desired improvement with less cost than any other plan of organization. It will be less costly, for the reason that the district improvement is on a sufficient scale to provide good engineering talent, and good supervision; fourthly, it will meet with less opposition since it permits the

organization of people with a common interest, and provides for the distribution of the cost among all those benefited.

What may seem as a model of the method proposed has already been tried with success as applied to public drainage, and this has resulted in much good, and serves to indicate that such a scheme is feasable and will be successful.

THE NEW ROAD LAW.

BY SETH DEAN, GLENWOOD, IOWA.

What shall the new road law be? This is the question that both engineers and taxpayers are asking at this time in a great many of the states of the union; and, truly, it is a much easier question to ask than to answer, for past experience warns us that, unless we can provide a better law in all respects than the one we have, the public will be the loser by the change. The first consideration of law-makers should be to so frame the law that the greatest benefit may be realized by the public for the least expenditure of money, not only in the first cost of the work, but in the annual cost of maintenance after the work has been constructed, as well. With this view the writer offers the following plan as his idea of the proper solution of the problem:

For the convenience of officers who have charge of the construction and repair of roads under the plan presented, they should be divided into four classes, as follows:

Class No. 1 should include all roads which now are, or are destined in the near future to be, main thoroughfares of travel. These are usually the direct routes between cities or business centers of the country. These roads, if not already established on the most economical route, all things considered, should be revised and, after a thorough examination of the country, be placed on the best ground, and then be made of proper width and grade to accommodate the travel, and the surface paved with brick or covered with some other material suited to the climate and conditions of travel.

Class No. 2 should include the principal routes of travel between the smaller cities or the principal towns. The

location of these roads should be made with the same care that those of the first class are, with respect to alignment and grade, and should be covered with some suitable material, not necessarily as heavy or expensive as that on No. 1, but suited to the conditions of the case.

Class No. 3 should include the principal country roads, usually those leading into the market towns or cities from the country. These roads should be located as much with reference to the accommodation of numbers of the people who will use them, as to the sole matter of grade, but they ought not to be diverted from their general direction to accommodate one or two parties. This class of roads, too, should be well drained, and, if circumstances will permit, may be covered with gravel or some other suitable material.

Class No. 4 may include all the so-called neighborhood roads, or those which, from their location, can at most be used only as a means of communication between small sections of territory, and for school purposes, but which the public has a vested right in, and is bound to keep in repair. This class of roads should be located, as much as possible, to accommodate the inhabitants of the section of territory through which they pass, and, if necessary, they may be located on almost any line or grade, so long as the location is one that does not endanger the lives of persons or animals that are compelled to make use of them; but, of course, a judicious use of practical common sense in their location will save the taxpayers money in the way of maintenance, and the public much vexation in their use. Next, all highway taxes should be collected in money by the county treasurer, and paid over by him on warrants issued by the proper authority. All work of construction or repair of roads should be done under some form of the contract system, the contractor furnishing a guaranty in the form of an approved bond, or to receive no pay until the completion of the work to the satisfaction of the proper officers.

HOW CAN THIS RESULT BE SECURED?

There should be appointed and duly commissioned, by the governor of the state, five persons, who shall constitute an executive board of highways, two members of which should be civil engineers and one a lawyer. The remaining members

may be men of business ability. The duties of this board should be to divide the state into suitable highway districts, consisting of, say one county, more or less, according to the circumstances of the case, having more regard to the density of population and the topography of the country than to the present political divisions, the design being to, as nearly as possible, adjust the total mileage of roads so that the cost of maintenance shall require as light a tax as possible on the people. They should determine all question of dispute in regard to the proper classification of roads made by the district boards, hereafter described, when appealed to them. They should examine and approve all plans for bridges on roads of the first class and the plans for all bridges of two hundred or more feet span on other roads. They should keep complete plats and records of the notes of location and profiles of grades, together with copies of the plans and strain-sheets of all bridges on roads of the first class; and in cases where roads of the first or second class run through two or more districts, they should have the power to call special elections to vote on the question of the issue of bonds for the grading and paving of such roads through the several districts, and a majority vote of the people of the several districts as a whole should decide the question (provided, however, that individual districts may, by vote, issue bonds for the purpose of paving or grading that portion of the said road that runs through their territory, independent of other districts, at any time they desire to do so).

They should have power to examine all applicants for the position of district engineer, and to grant certificates to all who can pass the required examination.

They should annually make a full and complete report of their work to the governor, together with such recommendations as they may think proper.

There should be created two offices—a superintendent of highways and a district engineer. These officers should be elected by the voters of the district, and they should each hold their office for a term of two years, and should give good and sufficient bonds for their official acts. Each should be permitted to name his own deputies, if any were required. And

before a person could be eligible for the office of district engineer, he should be required to pass an examination and secure a certificate from the executive board. The duties of these officers should be as follows: The two together to constitute a local board, who shall have a general supervision of all highways in their district, and make a classification of the same. They should divide the district into such number of precincts as may be most convenient for the purpose of contracting the work of maintenance or repair of roads and bridges to advantage. They should open all bids and award all contracts for grading or repairs on roads, and for the construction of bridges.

They should have the power to establish, alter or vacate highways when petitioned for by the citizens of the district; and, in cases of relocation of highways of the first or second class, they should have the power to condemn land for road purposes, or for the purpose of constructing proper outlets for drains through adjoining lands; but before commencing condemnation proceedings, such plans of drainage, or of changes in existing highways should be approved by the executive board.

They should annually file with the board of county commissioners, or other proper authority, a sworn statement of the amount of work done during the year on the roads in each of the different classes, and of materials or supplies purchased, and of the amount of funds on hand, and also with an estimate of the amount of funds that will be required for the maintenance of the roads and bridges in the several precincts for the following year, and also an estimate of the amount of money which can properly be expended in grading and paving or macadamizing of roads in the several classes, from which estimates the commissioners should make the proper tax levies.

They should annually report to the executive board the number of miles of roads of each class in the district; the amount of grading and paving or macadamizing done; the cost of the same; the character, amount and cost of bridges erected, and of repairs to existing bridges, together with an estimate of

the amount of funds required for the several purposes for the following year.

Besides his duties as a member of the district board, the superintendent of highways should have the general supervision of all highways in his district when the district board is not in session. He should receive all petitions for new roads, or changes in existing ones that may be filed with him by citizens of the district. He should examine all routes petitioned for, and, if satisfied that the new road, or the change of the old one, is desirable, should notify the district engineer to make a survey of the same. He should advertise for bids for the general repair or the construction of the roads and bridges in his district, and, after the work is awarded by the district board, should sign all contracts. He should purchase all supplies necessary for the use of the district in the care of the roads. He should issue all warrants on the road fund on the treasurer's fund of the county where the work was done, based on the monthly estimate of work done by the contractors filed with him by the district engineer. He should keep a full and complete record of all his acts, and a register, by numbers and amount, of all warrants issued by him, which books and records should be open to examination by the county commissioners or the executive board at all times, and should have his office at the county seat, or in the city or town most convenient of access to the citizens of his district.

In addition to his duties as a member of the district board, the district engineer should make all surveys of highways in his district, and properly mark out on the ground all construction work for the contractor, and keep complete records of the location and field notes of surveys of highways, together with plats and profiles of all grades established, and copies of the plans, strain sheets and bills of material of all bridges built, and copies of the final estimate or measurement of all grading, paving or macadamizing done. He should furnish the superintendent of highways with plans and, if necessary, strain sheets for all bridges, and for bridges on roads of the first class, and for all spans of two hundred or more feet in length on other roads; he should first submit his plans and strain sheets to the executive board for approval before finally

giving them to the superintendent for the use of builders. He, too, should have an office at the county seat or most accessible point for the citizens of the district, and his records, books, etc., should be open for examination by the proper county officers or the executive board at all times.

Such, in short, is the plan the writer would propose as a remedy for the present expensive system, in use in most states, of working the roads. That it may have weak points, he does not doubt, but he also believes that it possesses some merit. It is quite probable that some states have laws at the present time wholly or in part similar to the plan outlined here; if such is the case, the success or failure of the plan, where it has been put in practice, can be easily learned from those who have tried it, and who can readily point out its defects, for no amount of theory is equal in value to an experiment, in the matter of either making laws or putting them into practice. He is convinced, however, that the plan he has outlined will be productive of better roads and a material saving of money to the taxpayers in states that can be induced to try it.

WAGON ROADS.

J. H. FORSTER.

Admitting that good wagon roads are of great advantage to a country, and that our roads in general are not what they should be, not what they might have been, if the labor and work expended had been judiciously applied; we are of the opinion that better methods of improvement are in order.

We hope that some wise plans may be adopted from the general discussion of the state of our highways now going on, and that practical methods may be reached.

But in many newspaper articles on country roads, I think our country is treated unfairly. It is not fair to compare our country roads with those of Europe. Michigan for example is a new state. In Ingham county where I reside, the oldest settlers boast that it is 35 or 40 years since they built their first log cabin in the wilderness, reaching their destination by

Indian trails. Thirty-five, forty, even fifty years—what an age! Compare it with some older civilization which we call modern. The English, French and German people with whom we are unfairly compared in the matter of roads, have been building for a thousand years. Their primary teachers were the Romans. Good military roads were as necessary to those invincible historic conquerors as are railroads in modern times. They used their power and compelled the conquered people and innumerable slaves to work upon their marvellous thoroughfares. But as I understand it, their system of roads was limited, not general. They built only a few great thoroughfares connecting important parts of the conquered country. It was so on the continent.

But in Michigan no despotic power has hauled us out to work on the roads. On the contrary, we have lived under the mildest of regimens. Our Centurian has been the popular *path master* (not road master!) carelessly elected by a *viva voce* vote of men and boys, with no special qualification, no ambition other than to get through with the job of making bad roads worse as cheaply as possible. This statement is made in general terms; there are praiseworthy exceptions. Better, more carefully made roads are becoming more common. Many farmers are fully aware of the importance of good roads.

Many enthusiastic advocates of good roads will have nothing but stone, or McAdam throughfare. At this time the proposal is absurd. I have to work 1½ miles of road on my farm. A first-class stone road would cost say, $5,000 per mile. My farm would be taxed $7,500. It is assessed at $15,000, therefore it would take one half of the farm to build the road. But from whence is the money to come? By mortgage? The state would better confiscate the farm at once and set me at work breaking stone for a living. In no possible way could the McAdam ever reimburse me for the tax, even if I could pay it.

Therefore, so far as we farmers are concerned, I would say, "go slow."

Farmers use only certain local roads. In our section, owing to the nature of the soil as much as anything perhaps,

we have pretty good roads. By good drainage, turnpiking, putting gravel and sand on a clay road-bed and clay on a sand road-bed, good results follow. Our roads, even under a lax system are slowly improving.

The general public use all the roads in a county, and many who travel, pay little, if any road tax anywhere. So it seems to me if the present system of road building is to be improved or changed, the work should be placed in the hands of the state, and all villages and cities as well as townships and counties, all railroads and ship lines should be taxed to build county or state roads.

It would be unjust, unfair and ruinous to throw the burden of costly road building upon the township. You would kill the goose that lays the golden egg.

Unfair as it might seem at the first glance, to tax steamers and railways for land roads, I think upon examination the tax will not appear unjust.

In the first place, millions upon millions of the people's money are expended in the construction of harbors, light houses, locks, dredging, etc. The common roads of the country lie behind all these.

In the second place, good country roads are a very important factor in railroad traffic. What is the condition of things to-day, especially in the western states? Railroads may be viewed as the main streams of inland traffic. The common roads as innumerable feeders. It is of the utmost importance in railroad traffic that the flow of passengers and freight be strong and constant all the year round. But the choking up of the common road feeders by mud, is a great draw-back. When the roads are good after harvest, all of the railroad stations are filled to repletion. The farmer hurries in his produce irrespective of the condition of the markets, while the railroads are unable to remove the crop fast enough. All are working under undue pressure and at a loss on one side, at least the farmers.

During the muddy term, the railroads receive a minimum of freight and run empty cars into half stranded cities.

Good roads, all the year round would even up things and conduce to general prosperity.

In a new country like ours, under so many varying conditions, the permanent improvement of country roads must be a work of time—much time. It will not do to force matters. The best engineering talent (such as we have here!) must be employed in planning and executing, supplemented by wise and honest legislation and *administration*.

HIGHWAY LAWS OF NEW YORK.

BY O. C. GILLETTE.

At the request of our secretary, I have made the following digest of the highway laws of the state of New York.

There has grown up in this state in process of time, a vast body of fragmentary and disjointed legislation, and it requires more skill than I possess to tell in all cases what is law and what is not. For instance: I read through two or three pages of an enactment in reference to highways lying in two or more towns of a county, only to be told in the last clause that this act applies solely to counties lying contiguous to cities having a million or more of inhabitants.

In each town in the state outside of cities and incorporated villages, there are annually elected one or more commisioners of highways. They have supervision of the roads and bridges of the town. They are to divide the town into road districts and to appoint officers called Path Masters, who see that the highway tax is properly worked out on the roads. The highway commissioners may expend not to exceed $250.00 on the roads and bridges of a town. If they require more than this, they must give due notice previous to the annual town meeting, stating the objects and the particular amount required for each.

They may cause a survey of roads which are not well described, or which, though not regularly laid out, have been in public use twenty years or more.

They may buy a road scraper, and the supervisor may, if the electors at an annual town meeting shall so vote, purchase a stone crusher for the use of the town.

All male inhabitants of the town between the ages of twenty-one and seventy are liable to be assessed a road tax, to be worked out on the highways of the road district in which they live. There are certain commutations.

There is a cash commutation, also if a person takes down his highway fence where snow is liable to drift, he may be allowed the cost of taking it down and putting it up again. If he erects and keeps lighted a street lamp, he may be allowed not to exceed six dollars per annum for that service. If he plants shade or fruit trees along the highway he may be allowed on his highway assessment, one dollar for each four trees planted, up to one-fourth of the amount of his tax for that year.

No road may be laid through any orchard or vineyard, without it shall be declared necessary by a commission of three, appointed by the county judge, and they shall apportion the damages, and their proceedings shall be approved by the appointed judge.

There are certain fines for driving over bridges faster than a walk. These fines vary from one dollar to twenty-five, according as the span of the bridge varies from twenty-five feet to two hundred.

Any bridge whose length is two hundred feet or more, or which has any span of one hundred feet or more, need not be accepted and paid for by the town until it has been tested by the state engineer, and been declared to be a proper bridge, and built according to the contract. All bridge contracts are made subject to this provision.

Bicycles and tricycles are regarded as carriages, and are under the rules.

The country roads of the state of New York are about as bad as they can be. The soil of a large portion of the state contributes to make them so.

I need not describe to you the vicious results of the system of working out highway taxes under the direction of someone who ordinarily has no conception of how to make a good road.

Eli Perkins says, "The average farmer does not know how to make a good road, God never intended that he should." It seems to me that when roads are laid out, made and main-

tained under the supervision of skilled engineers, then we shall have good roads the year round, with scarce any more, perhaps even with less expenditure than at present.

FLORIDA ROAD LAWS.

S. C. HODGMAN.

To the Members of the Michigan Engineering Society:

I have been requested by your Secretary to give you some information in relation to the road laws in Florida. This is quite a difficult thing to do, as the state of Florida seems to guard her laws with a jealous care lest someone not of the elect should find out what they are and make hard times for the lawyers. After many trials I have succeeded in getting a look at a copy of the law of 1888, which was amended in some particulars by the last legislature, and have been told what the alterations were.

To begin with, in order to understand fully the law, a sketch of the system of local government is necessary.

In that system the county is regarded as the unit and all local government is subordinate to it. The county is divided into commissioner's districts. In this (Polk) county, consisting of about fifty-five townships, there are five such districts which are also subdivided into precincts for voting purposes, the precincts sometimes consisting of several townships. A form of election is bi-ennially gone through with which does not elect, but recommends the successful candidates to the governor for appointment. (This is in order to keep the darkey out). The commissioners form the county government—with some oversight from the county court. Local or neighborhood officials are few and far between. Even the common schools are dependent on the county board of school commissioners for everything—teacher, salary, length of term, repairs of school house, etc.

The title of the law is

An Act to Provide for Placing and Keeping in Condition the Public Roads and Bridges, and the Laying Out and the Construction of the Same, and the Raising of Revenue for that Purpose.

SECTION 1. Each county commissioner's district is made a road district. (Remainder of section repealed.)

SEC. 2. Repealed.

SEC. 3. Provides for the examination of roads and bridges, ascertaining the number of miles in each district.

SEC. 4. Shall advertise at least four weeks for contracts for keeping in repair roads and bridges, also "making, altering, working, repairing, fixing and constructing roads and bridges."

SEC. 5. "The working, making, altering, repairing, fixing and constructing" shall be let out to the lowest bona fide bidder by districts for one year, contractor to give bond, etc.

SEC. 6. Superintendent (commissioner) to personally examine from time to time all roads and bridges of his district—necessary work or repairs to be done at expense of contractor.

SEC. 7. Repealed. (Male persons over twenty-one and under forty-five, subject to work not less than three or more than six days.)

SEC. 8. Repealed. (Superintendent to furnish names to contractors.)

SEC. 9. Repealed. (Contractor to give notice of time and place to work.)

SEC. 10. Repealed. (Penalty for failure to work.)

SEC. 11. Repealed. (Justice of peace to issue capias for defaulter. May commute at 33⅓ cents per day.)

SEC. 12. County commissioners shall levy tax of not less than one mill or more than two mills on all real and personal property subject to taxation, as a road fund (and for no other purpose).

SEC. 13. All bills and accounts to be audited by board of commissioners, and paid by their warrant on county treasurer out of road fund.

SEC. 14. Pay of commissioners $2.00 per day (no extras).

SEC. 15. Same.

SEC. 16. All new roads to be on section or subdivision lines, or as near as practicable.

SEC. 17. Width of all public roads to be not less than twenty feet (no provision for sidings).

SEC. 18. Commissioner shall erect mile and "sign posts;" shall have roads graded when necessary by ditching and crossWaying wet and boggy places.

SEC. 19. Repeals all laws inconsistent, etc.

SEC. 20. This act to take effect on approval of governor.

It will be seen by this summary that there is no provision for a survey or record of a road—no provision for condemnation of lands for a route, and no provision for damages in any case. The lands of non-residents may be traversed in any direction at the will of the residents without redress, unless through the courts.

When a public road is desired by the residents of any locality, a petition, with as many signers as possible, is presented to the county commissioners, accompanied by a rough diagram giving a more or less approximate idea of the location of the road. No notice is given to non-residents or others interested. The commissioner for that district is supposed to examine into the matter and recommend, or otherwise, the laying of the road. If he reports favorably, the board declares the road laid out. If any damage is claimed the petitioners must pay it—the county will not—at least in this county. The commissioners seem to vie with each other in saving all the expense possible to the county, and the one who shows the least expense is the best man—for re-election.

When the commissioner chooses, he can recommend the building of a bridge or crossway at the expense of the county.

There is something to be said in favor of this system as the country is now situated. Travel is not confined to roads except when the land is fenced on both sides, and it is expected that when the country is more thickly settled that new laws will be called for to suit the circumstances. I have an impression that in some of the older counties the whole matter of road laying, building and repairing is left with the county, and they make their own laws on that subject.

In case a person wishes to enclose his land through which a road runs, he can petition the commissioners to change the

route, which they will generally do, on a proper showing, unless natural obstacles prevent.

The improvements that I would suggest are that a system of main roads should be provided for, which should be kept on lot lines as nearly as possible, unless inconsistent with the best grade. Those main roads should be carefully surveyed and monumented, and a full set of field notes and a correct map of the same filed in the proper place.

That a county or district engineer should be appointed who is an expert in the laying out and construction of roads, and who should have the whole charge of the details of laying out and working those main roads.

That the whole amount of the highway fund should be expended on those roads, except, perhaps, what might be necessary for bridges on local roads. And when there is no necessity for removing obstructions on those main roads, the funds should be used for the improvement of the road bed by claying or otherwise, so that the result would be, in the future a complete system of good solid roads, mere local roads being left to the care of those who use them until the main roads are completed.

That the width of main roads should not be less than forty feet, of which at least twelve feet should be reserved for sidewalks. The road bed when made to be confined to the center of the road, and the planting of shade trees should be provided for.

Provision should be made for the condemnation of right of way and liquidation of damages where damages are claimed; also for written donation of right-of-way by a definite description of the land used for the road.

Provision should be made for the expenditure of the highway moneys in the localities where they are raised, instead of using them as a general county fund, to be expended where the interests of the commissioners may indicate.

The conditions of the highway problem are very much different from what they are in Michigan or any of the northern states. The soil is different. Heavy teams are not required for farm work and, as a consequence, are used very little upon the roads, nearly all the hauling being done with one horse or

mule, or by a pair of small oxen. Sometimes, even, one ox is used in a primitive cart. From four to seven hundred pounds is the usual load. As more northern, or *progressive* southern people come in there will probably be a demand for better roads. They will, bye and bye, begin to see how much time, labor and capital is wasted in going to town or coming home with a quarter of a load on the wagon. It seems but little now, but it will appear large enough when they begin to reckon it by the year.

I am inclined to think favorably of a "local option" in highway matters, so that more advanced counties can control the system best adapted to their needs, while the less thickly settled ones could use a simpler plan until a better one was needed.

I will not, in this paper, enter upon any discussion of the engineering problems involved, as they would not, probably, be of much, if any, interest to *Michigan* Engineers.

I take this occasion to assure you, gentlemen, of my continued interest in all your doings and that, did Providence permit, I would be very glad to meet with you again and to take my old acquaintances by the hand (but wouldn't my teeth chatter?). If I could be transported instantaneously, I would come loaded with flowers and fresh fruits for your delectation.

Haines City, Polk County, Fla., Dec. 16, 1892.

ROADS AND ROAD MAKING IN OKLAHOMA.

BY JOHN J. WATKINS.

A very brief description of Oklahoma may not be out of place before entering upon the subject matter of this paper, as indicated by its title.

Oklahoma, especially around and about Guthrie, the capital of this territory, is mostly a rolling prairie, interspersed with numerous small streams, many of which go dry, or nearly so, in a dry time, with patches of timber—oak, elm, walnut etc, lining the banks, as well as scattered in openings here and there upon the prairies.

Nature seems to have vied with herself in forming the beautiful landscape of this new country over her former efforts in the older settled countries or states. Its beauty is not one of awe inspiring, like craggy cliffs, lofty peaks or deepening canyons beyond the power of the eye to penetrate, but one that fills the whole soul with ineffable delight, awakening responsive chords in the soul's soliloquy—

"Here let me live, if live I may,
For many years while locks grow gray;
When parting time have bekoned me
On hill top lay, then shall I see
In rising at the trumpet's blast,
E'en grander sights than were my last."

Aside from the beauty of locations for settlements, the fertility of the soil is the great attraction of the many who are seeking homes here. Contrary to general expectation, the uplands in many cases are fully as productive as the bottoms; and for cotton and corn, are seldom inferior in quality and quantity of the crops, while much more easily broken up, and can be cultivated at all times, wet or dry.

The fertility of the soil is probably due to the complete admixture of clay and sand; the clays not being tenacious, but quite ochreous; and the sand without much grit, and largely devoid of gravel; in fact, you may in many places on the uplands chop all day into the earth with a sharp ax, and scarcely perceive the edge to be blunted or rounded.

On the opening of this country to settlement, home seekers whether afoot, on horseback, or in "prairie schooners," (covered wagons,) went or drove ad libitum in any and all directions; in consequence, roads were made cutting each other at all angles, because of the feasibility of traveling in the directions desirable and securing a good road, except when the streams and "draws" or ravines made it necessary to diverge from the chosen direction, and pursue a course along the side of the stream or "draw," to obtain a fording place over the stream, or a crossing place through the "draw" on a lower plane, where ascent would be less difficult.

Roads, it is very probable, over grounds in a state of nature were never found better in any state or country than in this

territory; in fact they are to-day, with all the immense travel and the heavy freighting from place to place, in very fair condition, except in siding places, or on the ascent of hills, with scarcely any road labor having been performed; on the places referred to with the constant travel and heavy freighting they become worn. After heavy rains, under such circumstances deep cuttings in these porous soils are inevitable.

In the old Texas cattle trails which pass through this territory, are to be seen cuttings caused by rain and travel of from four to eight, and even ten feet deep; of course the latter are on hill slopes; even in the city of Guthrie on the side ditches when there is much descent, in some streets the wash and cuttings have been made from ten to twelve feet deep; in fact from the looseness of the soil on account of its admixture, there is great tendency to wash and cuttings on all the traveled roads.

By federal statutes as well as territorial, all section lines are declared highways, and are being fenced out and worked some.

In counties and townships each, the highway and bridge tax, is five mills on the dollar; this while seemingly quite adequate, provides but a small fund, because so little of the land is "proved up," the title being yet in the government and not liable to tax; but the poll tax is four days or dollars per capita for all men not over forty-five, and from the fund thus derived, the most of our labor on roads is secured,

Every "draw" or ravine needs bridging as well as the streams; this makes a necessity for an ample road and bridge fund, while so little is available, consequently roads cannot be made as they should be, and the country is checkmated in its progress accordingly; but it does progress notwithstanding these disadvantages, and that "right smart," as the western or southern people say.

Each township trustee divides his township into as many road districts as he deems necessary. In this township, and generally throughout this county, (Logan,) they are divided into four, the same as the school districts, giving nine square miles to each district. The road overseer cannot charge for more than twenty-five days work, however many he may be occupied, at one dollar and fifty cents per day. In this district

No. 2, Guthrie township, having all the roads leading to and from Guthrie, with all the incoming and outgoing travel, heavy freighting to surrounding towns, log lumber, wood, brick, stone or rock, and sand hauling from the Cinnamon river for the needs and building up of this growing city, now over ten thousand, makes an outlay of from fifty to two hundred entry days necessary for the overseer with but twenty-five days pay. Great are the honors of overseer road district No. 2, Guthrie township!

Now for the second part of the paper, *road making*. The main travelled road from Guthrie to Downs, Kingfisher, El Reno, Reno City, and the newly opened country of the Cheyenne and Arrapahoe reservations, became next to impassable on the hill slope immediately west of Guthrie. This was said to be the worst piece of road between Guthrie and the before mentioned cities. By heavy rains and constant travel of four and six horse freighting teams, the wash had cut the road in fearful holes and trenches down to the bed rock, which underlies the surface soil from two to ten feet on many of such slopes. The road overseer of district No. 2, Guthrie township, started out to repair it, being in his district, and did it in the following manner.

The rocks that were laid bare were broken and picked off on the tops of some, others were blasted and the debris broken into sizeable pieces, the holes and trenches were partly filled or riprapped with this material; next small saplings and brush were cut in the adjoining timber and laid on this riprapping with the tops uphill, commencing at the top of the hill, making them shingle in layers one upon the other, care being taken to lop the branches so as to spread them in fan like shape when adjusted in the trenches. They were put into the washouts from three to four or more feet deep, as the occasion required, for nearly one quarter of a mile, the fills being from four to six feet wide, and as many feet above the ordinary surface of the road; these were weighted down with heavy fence posts, with occasionally a man or two's weight on top as the covering progressed to keep the scrapers from disarranging the layers. We commenced to cover at the foot of the hill, first with scrapers full of broken rock, then of earth; as the brush and

saplings became well covered and somewhat compressed, the fence posts, one at a time were removed *farther up hill*, and in this manner to the top of the hill, As soon as we had any part covered the travel was turned upon it so as to more thoroughly compress the timber and pack the other filling before the crowning of the road bed should take place. While the work of filling the trenches was taking place, other teams and tools were employed in plowing the side ditches. Most of the way it was soft rock, which with a heavy road plow with coulter, two or three men riding the beam and sufficient teams, we were enabled to plow some furrows; then came the scraping out; this was continued alternately plowing and scraping, till we had side ditches four feet deep and wider than deep. Where the rock was too hard for the plow, men with picks, crowbar, sledge drills and old axes, subdued the refractory portions.

After the road bed had been properly filled and ballasted with broken rock, came the crowning, which was done in the ordinary manner with scrapers, after which came the levelling and smoothing of surface of road bed. As we had no grader we were left to our other resources, and as the adage has it, "necessity is the mother of invention." We took the fence posts used for compressing the timber, laid them side by side as the pieces of a harrow with the distance of six or eight inches apart and chained them in such a manner; then in hitching to it with two span of large horses, one end or side was made to be in advance of the other about two feet. The two drivers mounted *this grader* standing up, and thus this road bed was levelled and properly crowned. Of course, it will be understood that these posts were made to run nearly perpendicularly to the line of the road way. What obliquity there was, was given it by running one corner in advance of the other as before stated.

Lateral ditches, quite shallow, were run diagonally from the road bed to the side ditches, so that no part of the road bed had to carry any water except what fell on its immediate surface, and that by the crowning was quickly conveyed by one of the lateral ditches to the side ditch. There were probably a dozen of these laterals on each side of the road bed.

This road takes all the travel westward from and to Guthrie, and has been in wear since last spring, and notwithstanding the present year 1892 has been unprecedented for very heavy rains with attending cuttings, still it has stood the test during this time without wear to any considerable degree, and only as might naturally be expected. From being the worst road in Oaklahoma, it is now acknowledged to be the best hill side road from Guthrie to the Cheyenne country.

This is one of three roads repaired or built in the same manner, all of which are doing good service.

Now comes the question, why commence at the *top of the hill* and shingle the young saplings as set out? Because the waters that may run upon the road at the upper end, will after seeping through the earth to the timber, follow the timber to the riprapping below, and then will course through the stones till lost in the earth, leaving all the material above the riprapping in place and the whole structure remains solid. But had the fill from the saplings been made from the lower end up the hill, every rain would have laid bare the lower part of each course of the filling, and made just so many places for the water to ooze out and widen the old cuts. It should be observed that the riprapping on the road bed before the crowning caused the crown surface to dry out very much sooner after each rain, and tend to solidify the road bed as well as its preservation, enabling it to resist the heavy pressure of the freighting teams.

January 1, 1893.

GENERAL STATUTES OF NEW HAMPSHIRE —MAKING AND REPAIRING HIGHWAYS.

RAY T. GILE.

1. Towns shall annually raise such sum as they judge necessary for the year, to be assessed and collected as state taxes, for making and repairing highways and bridges therein.

5. Towns may choose as many surveyors of highways as they think proper.

6. If none are so chosen, the selectmen shall appoint surveyors.

7. Surveyors enter upon their duties on the fifteenth day of May.

8. On or before May 15, annually, the selectmen shall limit the several surveyors' districts, and give to each surveyor a list of the persons in his district, with the highway tax against each, and a warrant to collect the same.

9. Every surveyor shall give to each person named in his list, or leave at his abode, a notice of the amount of his tax, and of the time when, the place where and the tools with which he shall attend to work out the tax, four days before the day appointed, and may require any person to work out not more than one-half his tax in labor of animals.

12. The town may determine the prices to be paid for labor, materials and use of tools applied in working out the taxes; if not so determined they shall be fixed by the select men.

13. The surveyor shall allow to each person attending to work out his tax, the time necessary to travel from and to his home.

17. If the highway taxes in any town are insufficient for the suitable repair of the highways and bridges therein, the selectmen may cause them to be put in repair at the expense of the town, but not until the money raised by the town has been expended.

24. Highway taxes shall be paid in money, when the town, at the time of raising money for which the tax is assessed, so

direct; and such taxes shall be committed to the collector, and when collected shall be expended in repairing the highways, by the selectmen or surveyors of highways, as the town may direct.

27. Towns may, by vote or by-law, authorize their selectmen to contract for keeping their highways and bridges, or any part thereof, in repair for a term not exceeding five years.

37. Towns are liable for damages happening to any person, his team or carriage, traveling upon a highway or bridge thereon, by reason of any obstruction, defect, insufficiency or want of repair which renders it unsuitable for the travel thereon.

Highways not in any town or place liable for the repair of highways shall be made and repaired by the county; and every county shall be liable, as towns, to individuals and to the public for neglect therein.

F. HODGMAN,

Dear Sir:—Many of the towns in New Hampshire still cling to the Highway District system in the repairing of the county roads.

In the town of Littleton the farmers are unwilling to adopt a new plan. It is customary for the town to raise one-fourth of one per cent of the total valuation each year for the repair of highways. The inhabitants of the village have tried for several years to get the town to adopt a better highway plan; but failing in that they have recently had the village set off, by the action of the state legislature, into a separate highway precinct.

It is proposed to begin the use of broken stone on the streets. I think, in time, the farming community also will be led to see the advantage of better roads and be willing to help pay the expense of making them so.

In our town, this year, outside of the village highway precinct, the highway tax was raised half in money and half in labor.

Littleton, N. H., Dec. 27, 1892.

RAILWAY AND HIGHWAY.

H. E. RIGGS.

The last three or four years have seen a decided effort on the part of our citizens to secure better public roads. Engineers have discussed the matter more thoroughly, and it has been brought to the attention of the public at large as never before, through the medium of newspapers and magazines.

It does not require much of a student to get at the point of the statistics. Good roads pay, and they pay well. It would be the greatest godsend to the people of this country could we have such a system of roads as France possesses. The stagnation of business in our smaller towns in certain seasons of the year would be greatly reduced; the farmer would be enabled to reach the markets with his produce at all seasons; and he, as well as the consumer of his produce in the cities, would be financially ahead.

I have been asked to say a few words on the relation of the railroad to the country road, and have also been asked what, if anything, the railroads should pay towards the cost of improving these roads?

If I may be permitted, I will lose sight of the term "country roads," and give a few remarks on the relation of railways to all roads crossed by them.

That railway companies suffer a loss of revenue on account of the villainous dirt roads and narrow tires in use on them, I do not question.

I do feel that it would be impracticable and impolitic to call on the railway companies to contribute a sum of money to be expended on highways under the direction of any such road officials as we can at present boast. A railway company has so many items of expense which are outside of the cost of the maintainence or operation of its road, and its relations with the people at large are frequently of such a nature, that any demand for additional taxes, and particularly for such a use, would be met with refusal and with long continued opposition in the courts.

It is to be regretted that the relations between railway managers and the people are not as harmonious as they should be. There has been a tendency on the part of demagogues and politicians, in order to gain a certain kind of petty notoriety, to raise the hue and cry against railroad companies. Newspapers have taken up the cry, and have aided in creating a popular feeling of distrust and enmity toward this class of corporations. I think that it is the farmer who is most suspicious of the railroad companies. I find this spirit of distrust most strong away from the cities.

This state of affairs should not exist. It has led in some states to legislation alike ruinous to the interests of railway and state.

Permit me to quote from a recent report of the railroad commissioners of the state of Kansas:

"It is believed by the board that questions of paramount public concern enter into the business of railway construction and management; questions of statesmanship most difficult to master with justice to the public and the companies, a solution of which can never be successfully reached without a recognition, as a fundamental fact, that public and corporate interests in this relation are so completely identical as to involve the prosperity or adversity of each in that of the other. They are moulded from common element of mutual interest and dependency."

The railway companies are closely allied with the people in their efforts to build up a state, and they share the burden of taxation; they open up remote districts to settlements; they are makers of cities.

I think I can safely say that the manager of every line of road in the country will join most heartily in any effort to build up any county or city through which his line passes. He will do so from exactly the same motive as would influence any other business man, awake to the best interests of his business.

There is one feature in the relation of railway and highway that is of highest importance, that involves an annual expenditure of much money and an annual loss of many human lives. That feature is the *crossing*.

You will all admit that a railroad crossing your highway at grade is an element of great danger. It is particularly so, if

by reason of obstructions a clear view of the tracks cannot be obtained.

A glance at statistics will show that more lives are lost every year at grade crossings than are lost in what is supposed to be one of the most dangerous of occupations, that of coupling cars. More people are killed annually at grade crossings than are killed while riding as passengers on trains.

The following figures taken from such of the Michigan reports as I have will bear me out in this statement:

Date of Report.	Killed at R. R. Crossings.	Killed Coupling Cars.	Killed Passengers.
1886.	8.	11.	2.
1888.	19.	10.	7.
1890.	29.	24.	7.
1891.	26.	8.	5.

This shows something of the need of proper protection of life at these crossings. From the commissioners' report just issued I see that there are in the state, 7,493 road crossings, of which 211 are either overhead or under crossings. Of the grade crossings 495 are protected by flagmen, gates or automatic signals, while 6,998 are unprotected except by the sign board required by law.

The loss of human lives as shown in the reports given, in all probability represents a large expenditure in settling claims. During the same years nearly as many people were injured at crossings—another probable expenditure for damages.

I believe that it is for the interest of railway companies as well as of the public, that these crossings be protected. Where the crossing is in the country, the view unobstructed and no extraordinary travel on the roads, the sign board required by law is generally sufficient. In towns and cities where there is more travel on roads and more general use of tracks by engines and trains, some means of protection should be afforded.

The best, in fact the only certain means of protection is the total abolition of grade crossings at important points. There are few, if any, railroad managers in the country who would not heartily wish that *all* grade crossings could be abolished. It is a pleasure to know that many roads are mak-

ing this necessary improvement as rapidly as possible in the cities.

The maintenance of gates, with the necessary attendants or flagmen, is costly and unsatisfactory. Hardly a week passes that our attention is not directed to some accident at such a crossing. In Chicago a few weeks ago eight or nine lives were lost by a street car being struck at a crossing protected by two flagmen. Parties using the road take greater risks at these so-called *protected* crossings than where there is no protection but the sign board.

I should favor an effort to secure the co-operation of the road officers and railways, and let the railways pay their share of highway improvements in the erection of substantial viaducts at all main arteries of travel. Let the county or township grade and pave the road and approaches to the viaduct and ask the railway to provide the bridge. When done your road will be safe and a matter of pride to all.

To summarize briefly: 1st. Any laws passed and put in force, that will tend to improve the highways, increase business and afford constant access to the outlying districts, will be of benefit to the county and state, and as a natural result cannot but be of utmost benefit to the local business of the railroad companies, owing to the close relations and mutual dependence of public and railway interests.

Secondly, The railways can best aid in the construction and maintenance of these roads by abolishing, so far as possible, grade crossings at the main arteries of travel. I do not think that any special road tax should be levied on the railroad companies, but an effort made to secure their co-operation in the erection of viaducts, and have the railroad proportion of expense levied in this way.

THE RELATION BETWEEN RAILWAYS AND PUBLIC HIGHWAYS

AND HOW CAN THE RAILWAY COMPANIES BEST ASSIST IN THE IMPROVEMENT OF THE PUBLIC HIGHWAYS, AT THE SAME TIME FURTHERING THEIR OWN INTERESTS?

E. FRENCH.

In the recent discussions regarding "better roads" it is not unusual to hear the opinion expressed that "all the freight will eventually reach the railways regardless of the condition of the highways." This, I believe, will not be true so long as corn is used for fuel in the west, straw and other products of the soil are burned all over the country, and forests are left standing for want of facilities for transportation of the product.

The relation between each particular railway and the highways in the region through which it passes, is dependent upon so many and such diverse circumstances that each must be in great measure a law to itself, and we can hardly do better than to consider briefly some of the circumstances under which railways might reasonably be expected to aid in the improvement of highways.

1st. In the case of a fertile district or town lying about midway between two competing lines of railway, where the improvement of the highway leading to one of the lines might secure to it the bulk of the traffic from such district or town.

2nd. In towns where there are two or more lines of railway, the one whose depot is farthest from the business center may secure the bulk of the traffic by a judicious expenditure in the improvement of the highways leading thereto.

Although these are special cases, they are the ones that railway managers will insist upon having attended to first with the means they are asked to appropriate for the purpose. They will also insist that none of the means appropriated by them shall be used in increasing the facilities of their competitors.

While they will admit that the *general* improvement of highways will make a considerable accession to the earnings of their

lines, they will hardly consent to join voluntarily in such general improvement for various good reasons.

1st. Uniform voluntary action (if desirable) would be impracticable.

2nd. The benefits accruing to the railways would bear no adequate proportion to the benefits accruing to farmers in the increased value of their lands, to say nothing of the decreased animal power required to carry on their operations.

3rd. We in Michigan can hardly say where a through trunk line could spend money on the improvement of highways to the best advantage of itself, for although these lines may pass our very doors in Michigan, is it not possible that the condition of the highways in Kansas, Nebraska or Dakota may affect their interests much more vitally than the condition of highways at any point within our own state, upon the same principle that the advertising matter of a railway is generally distributed upon other than its own lines, or that agents are allowed commission on tickets sold over connecting lines?

Again, railways as public servants are obliged to keep constantly on hand the facilities necessary to move the traffic that comes to them, and in general any measure, such as the improvement of highways, that will cause this traffic to flow in a more uniform stream must have the effect to enable them to handle it more cheaply than when it comes in floods followed by corresponding periods of depression.

Yet Michigan is peculiarly situated in that the trunk lines passing through her territory derive the bulk of their through traffic from the region naturally tributary to the great lakes, and are crowded with business during those months when navigation is closed; and this usually is the time when highways in Michigan are at their worst, and the local traffic is depressed accordingly, while the through traffic is at its height. This, of course, is as this particular class of railways would wish to have it, as a congestion of business is inevitable with them in any event, and the improvement of the highways in Michigan would, in my opinion, tend to further complicate the matter.

In conclusion, I can see no way in which the co-operation of railways can be secured in this matter, except by the usual methods of assessment or taxation.

LEGISLATION FOR BETTER ROADS.

GEO. E. STEELE.

The legislature is invoked whenever anything goes wrong in the economy of the state, even to attempting to make men temperate. A large part of the precious time of the law making body is taken up in changing the name of Miss "Fide Bona" to Miss "Bona Fide," and such like, of vast import. It may be readily guessed, after making these startling statements, that we are not of the class which has implicit confidence in the legislature at once setting us on the macadam road to glory, all in the "one horse shay." Revolutions do not come by the flirt of the executive pen—except in South America. We must be content to ask the legislature to do the very best it can, as quick as it can, for the *patient* is *very low*. We must then hold up our hands and promise to do our part. Then the era of good roads will begin to throw out a faint light in the East—following it, the clear day.

It need not be expected that the legislature will move far in advance of public sentiment; and this sentiment is not at present educated up to the point of demanding good roads. Some are taking advance ground, and the subject is having general attention, but the most of our people do not realize how much is lost by bad roads. They easily fall into the ruts of "well enough," or "cost too much." Although we are somewhat behind some of our sister states, we are vaccinated, and will in due time break out with "road rash."

This period of organization must precede all else, as well in road building as in other lines. The legislature is handicapped by the constitution, which prevents it from vacating or altering any road laid out by the high Commissioners of Highways.

Article IV, Section 23, and under 11 Michigan 155, and 20 Michigan 95, confines this action to state roads, by delegating the power of Boards of Supervisors. Also by Article XIV, Section 9: "The state shall not be a party to, or interested in any work of internal improvement, nor engage in carrying on

any such work, except in the expenditure of grants to the state of land or other property."

Under this it has been decided, "that township, highways, and other local interests cannot be taken from the custody of the proper local officers." This makes the highway commissioner the *sine qua non* of township roads, or to translate the Latin, he is "Big-Injun-Me."

See also 15 Michigan 347, and 34 Michigan 46, where the commissioner is given full power to lay out, alter, or discontinue highways. I cannot here enter into a discussion of these constitutional restrictions. Whatever may be done to make the constitution a help to good roads, must be preceded by a thorough school house campaign of education, or the amendments will be killed by popular prejudice. In view of such misleading error, I believe more can be accomplished if the legislature does not at first attempt too radical changes. I admit that most radical changes are needed, but we are not to expect suddenly to emerge from the "corduroy" road to the "Appian Way." Then, in my judgment, such a plan should be adopted as would, by increasing public attention and appropriate legislation, gradually bring us into better condition.

Let us map it out.

1. Preserve the township system with some modifications for local or unimportant roads.

2. By a local option plan provide that any county may set in operation a county system with three county commissioners, who are distinct from the board of supervisors, and who shall have power of location, construction and maintenance of the most important thoroughfares. If these were treated as "State" roads, they would, under present decisions, be free from control of the township commissioner.

3. Have a county engineer who shall locate all town and county roads in conjunction with the officers named; map carefully all roads, set out work for contractors, and see that their work was properly done.

4. Do away with all building of roads by the state at large, and make the laws we have, so far as applicable, to conform to new county system.

5. Provide that by vote of the people of any county bonds may be issued, guarded by such low rate, long time, and provisions as would seem best. This money only to be used for a few important roads.

The modifications of the town system would be mainly as to the power of the commissioner to locate or alter highways. There is no check on this officer. He lays roads in the most hasty manner, and sticks to the section lines if they are well nigh impassable. We have lost enough by this poor policy already in state roads and highways, to have built a stone road the whole length of the state. As a surveyor, I have been called upon to make such locations as I knew were not best, but had no power to do otherwise. A road should be located by a capable engineer with as much care as a railroad, (permitting heavy grading,) and with curves instead of abrupt angles, all being thoroughly monumented. Authority should be given in this direction, and also to alter roads laid out so as to improve them. We would then stop expending money where it was worse than thrown away. Such poor locations are expensive luxuries. By proper application certain portions of roads already laid out could be condemned, these portions thereafter to receive not one dollar of public money. The new and best location would follow as a matter of course. The older parts of the state have their roads located, except as improvement of location could be made. But it must be remembered that, over say one-half of the state, new roads are being constantly laid out, and this will continue for many years. The question of location then becomes the very foundation of all subsequent expenditures, and should be committed to those best capable of giving it attention, free from local bias, and who make this work a study. This would be expected of the county board and engineer. It would be an advance to brush the dust off from the county surveyor and make an engineer out of him. The office is now of no consequence, and by making it the "Hub" of road construction, would be filled by men chosen with this in view, and become something besides an empty name. As to the state taking up the road building, it would seem that the day is passed. We have no use for long military or other roads. The railroads take the

place of such. We have already seen the misappropriation of hundreds of thousands of dollars in state road building, and if these are samples of state construction then deliver us from any more. County credit should be as good, or better than the state. The former cannot repudiate, the latter can. Those counties where first-class roads are built will find their credit thereby improved. Other counties not moving in the matter will retrograde.

DISCUSSION ON ROAD LAWS.

MR. HODGMAN: I don't think we want any state roads. I do not think any road would be of sufficient consequence to require the state to build it. When the time comes for such a thing it will pay to build a railroad, and when you have the railroad you do not want the state road. So I would divide our roads into simply two classes, county and township, or neighborhood roads.

For the support of the county road I would levy by statute an uniform tax of some reasonable amount, say perhaps, one mill. That should be devoted entirely to the work of building and maintaining county roads. I would levy by statute another tax of one or two mills, or whatever sum would be reasonable, for a township tax, to be paid in money for the support of common township roads. I think in the township of Climax we assess about one dollar for every eight hundred dollars of valuation. Suppose we make it two mills. That would be plenty, but I would adopt some fairly reasonable sum to be spread uniformly all over the state, both for the support of county roads and of township roads. If any sum greater than that was needed for the support of the county roads, it should be laid before the people of the county to vote upon, with detailed estimates. The persons who have the care of that should make a report to the board of supervisors of what road they propose to improve, the manner in which they propose to improve it, and the estimated cost; and that should be submitted to the people for their vote at the next election.

In the same way, the township roads should have a mill tax for their support. Make it a minimum sum. The person who

has charge of the township roads should make his report to the township authorities, showing what has been done during the past year, giving itemized statements of it in full, of what money has been expended, and the whole thing, so that every person in the township may know what was done with the money. If anything in addition to this mill tax was needed, require him to make a specific estimate to lay before the people of his township, stating what improvements are needed and the estimated cost, and let them raise it if they want to. In this way we keep the whole question of taxation before the people themselves to settle.

I would authorize the putting of tramps and vagrants to work on the road; authorize the highway commissioner to purchase the right-of-way for highways, at a price not exceeding the market value of the land, and in case he could not purchase it at that price, to call out a jury to condemn it. I should require a complete and accurate description of all road lines, whether now in existence or to be laid out, to be filed in the office of the register of deeds and in the state land office.

Country roads sometimes grow into city streets, and it is a very difficult matter to determine just where the location of that street is. I would require that these roads be established and monumented. There should be a permanent monument at every section corner and quarter section corner, and at every angle in the road, and a thorough description made. I would fix a suitable fee for recording and pay it out of the general tax I speak of having levied, both in the case of county and township roads. I would make the road laws apply to all platted streets outside of incorporated cities and villages. I would fix a penalty for destroying or removing monuments made to define road lines, and provide some manner of enforcing it. I would provide that all county roads should have permanent grades adopted; would have all heights of the county roads referred to a common datum, and if a road was on a county line, would have an established bench mark at the county seat, to which all heights should refer; show the heights of every railroad crossing; show the heights of the surface of the water in every stream; require it to be done, by law.

I would require all work done in constructing gravel and paved roads to be done by sections of some specific length, according to detailed specifications; and in case done by contract, not to be paid for in full until the specifications were complied with. I would require all graveling and paving to be completed to the grade as far as they go; adopt the grade first, gravel it as far as they go and finish it. If a road has to be plowed up, let it be but once. There might be exceptional cases where that might not apply.

I would furnish every highway commissioner with a good text book on highway improvement. I think we have people in our society to get up just such a book—some little book that, without taking much space, would go right into the fundamental principles of making roads and bridges, simply common short span wooden bridges and culverts, and giving specifications—and put that into the hands of every highway commissioner.

Now we have lots of highways in this state and everywhere else which require drainage. In certain classes of roads, clay roads especially, the most important thing is to have thorough drainage, and it is necessary to go across private property oftentimes to secure it. Hence, I would authorize the opening of watercourses across private property and provide a manner of condemning for right-of-way.

The only change I would make in the constitution would be to abolish the office of path-master and to extend the time of the highway commissioner. I would retain our present highway commissioners. I would organize a county board of highway commissioners to consist of the commissioners of the several townships. I would give to that board of highway commissioners the general control of all county roads; they should determine what roads should be county roads and what not, and authorize the expenditure of all the county funds under their direction; authorize them to employ competent road makers to supervise it.

I would require that board to make an annual report to the board of supervisors in detail—a report of all money expended by them, and where and how expended, and estimates of all improvements requiring additional money to be expended.

I would require each township commissioner to make a full report to the county commissioners, and the entire report to be consolidated and filed with the county clerk and in the office of the secretary of state.

These are the leading points I would suggest for the improvement of our highway laws. I do not think we are ever going to get any highway laws that will be perfect. It is going to be a question of time; there isn't any system that is perfect. I have corresponded and talked with engineers in other states where they have the county commissioner system, and there are grave evils connected with that. There is no perfect system, and you will never get such a one until you get a system that will put in office none but thoroughly competent honest men, men who will not be prejudiced, and they are so scarce we shall not get many. There will be no perfect roads until we get more perfect execution of the laws.

MR. HUBBEL: When I came into the Convention, I thought perhaps I had a few ideas on road making, and I flattered myself that perhaps some of those ideas were original, but after listening to the papers that have been read, I find that nearly all those ideas have been presented, so that my original ideas are mostly second-hand, and for fear that somebody will tell all the rest I know, I thought I would begin the discussion at this point.

The first point I shall make is this: We are often told that if some system of road making had been adopted twenty-five years ago and had been followed up, that by this time, we would have a splendid set of roads. If a system of making roads had been adopted in Michigan twenty-five years ago, and been followed up, we would have wasted three-quarters of the money put in. That is what I think about it. In fact we have wasted a large proportion of the money put into roads, and that waste has not been entirely because misapplied or not well done. The fact is, that the road problem in Michigan has changed, and the roads needed twenty-five years ago are not needed now. Years ago it was supposed that we needed state roads. They are of very little use to-day, and not because they never were made, and because many are not well laid out, but because we have no use for them. Men do not start out

to-day and travel thirty or forty miles on the common roads. Years ago a franchise might have been valuable, granting to a company the right to build a road from Lansing to Grand Rapids. To-day, a company would not think of accepting such a franchise.

So the necessity of to-day is entirely different from the necessity in years past, and the principal cause of this change in Michigan is the construction of railroads. People now want to get to the railroad and get there the shortest way possible. In place of laying roads from one town to another, we want a system of good short roads, all of which terminate at the railroad depot. Of course there are exceptions, but if you make a good road, or a good system of roads terminating at railroad depots, you will supply seventy-five per cent. of the necessities of the case.

Now, with this in view, any system of roads that you see fit to recommend, in my opinion, must take fully into consideration the fact that the travel is now by rail, and what we need are short roads, and roads ending at railway stations. Our roads want to be simply an extension of our railroad facilities.

It seems to me, that the only place we can begin to build permanent roads with the reasonable assurance that they will be useful for years to come, is to begin short lines at our railroad stations. The railroads are in the nature of a permanent institution, and the business is going to continue.

As for the classes of roads, I should think we need at least three. I think all classes should be upon some system, and have some specifications. I would have a first-class road, which is first-class in every respect—broken stone, or at least gravel. A second-class road which is also a good road, and a third-class road, which consists of ditches, and the spreading of the surface soil to support the road. By improvement it can be made a second-class, and by still further improvement, a first-class road.

We have heard some of our friends say, that the railroads would not do anything; that is the fact, if you tackle them in the way that was perhaps intimated by the paper.

The railroad will say: "We have built our railroad, and have opened up this country, and somebody else ought to

build the roads to reach the railroad." And still they are deeply interested in having these roads terminate at their stations. There is a way of enlisting the railroad corporation. I think the railroads would take the contract to build these roads—these short roads leading out from depots, and to be let under contracts and specifications. Nearly all railroads have a construction company, and if the railroad itself would undertake the contract of building these roads, I think the construction company could be induced to take the building of short roads radiating out. I would limit these short roads to three or four miles. I think in justice to the railroad, that a portion of the railroad taxes ought to be applied to highway construction. There might be a constitutional defect in that, but no matter about that, if it is just and right and proper, and the will of the people, that could be overcome in time. The railroads of the state, you are aware, pay no taxes to the township or county, nor do they contribute anything for the support and maintenance of the roads. They pay their entire tax in the shape of a percentage on their earnings. The amount of money paid in by the railroads last year, as taxes, was nearly a million dollars. This is put into the state treasury. The people of the country naturally feel that the state has taken from them the power to tax the railroads, and all the benefits to be derived, so far as immediate neighborhood benefits are concerned. Now, if one-half of the money paid in by the railroad to the state as taxes could be applied to the public highways, could be applied to a good system of short roads leading from railroad stations, it would be a very satisfactory arrangement, I think.

I believe it would be satisfactory to the railroad company as well as to the people. This would not be contributing in the sense of the paper read here, it would be allowing a portion of their money to be used for an improvement that would be a benefit to them. Now the exact way to get at this is probably a problem for some one better versed in legislative matters than I; but I think it is an idea that would be the beginning of the making of a system of good roads, starting from railway stations and emanating thence. This would be only a commencement, but if followed year after year, would soon amount to

considerable in the making of good short roads, which would be, you might say, examples. The people would see the benefit of a good piece of road and get an idea of the cost, and be induced to continue these good roads as far into the country as was demanded.

I would have these roads constructed, if possible, under the supervision of the engineer of each neighborhood. I know it has been said that the opening up of a new system of roads would make a good deal of business for engineers; this may be true, but the railroad can lay out and plan this work a great deal better than any independent engineers could be deputized and made to do it. I think the railroads would take the contract for building these roads cheaper than it would be done by anyone else. The railroad would haul gravel or would take the building of the whole road upon itself, if the bill for so doing, properly audited and approved, would be received at the state treasurer's office as so much of their taxes. It is simply enlarging on the old system of a man working out his taxes, and I think it could be made to work.

MR. GARFIELD: I came here to listen; I knew you were going to discuss roads, and I am greatly interested, and I wanted to see what this body, that I feel has more influence than any other one body, would say. If I can say just a word to show my interest, that is all I desire.

The growth of road building in our country thus far is a work that has not gone very far, and still I am not at all discouraged about it. I am more encouraged to-day than six months ago. I felt when this discussion began to take its new direction during last year, that we were just about as badly off as we could be with regard to roads, and whenever the question as to the betterment of them by some local legislation, came up and was defeated, I felt we were in a discouraging condition of affairs. But after spending nearly five months on the other side of the ocean, and looking into their systems, I felt encouraged, because I found the very best roads I traveled over were begun 1800 years ago, were founded by the Romans in their progress north. The very best roads in Switzerland are on the lines laid out by the Romans and added to from that day to this. We haven't lived but a little while, and all Europe

is small compared with us, and if we can only get a start in this century I shall be content. I think what has been said about railroad building is true. Road building has had a set back from the rapid increase in railways. I was glad to see one thing in connection with Switzerland roads. Two faults with regard to Michigan road building have been, first, that we thought we had no good material to make roads of, and when we found we had, people did not take advantage of it and find the places where the material was in abundance. The very best roads of Switzerland are made of gravel—not McAdam, but gravel. It is such as we find in our drift, and it is drift material such as ours, only it is a little closer to the fountain head. In the streams running away from the glaciers, it is rounded off and left in piles, and you find quantities of about the same size, and they shovel that into their carts, and take it as they find it. We have the same material scattered all over the peninsula of Michigan, if we only find it; but the great mistake has been, even after they found these gravel pits, that they took it just as they found it, instead of screening it and taking only that which was best. The gravel there is screened. Here, if we find a gravel pit that has enough sand, we think we are exercising economy if we put it on the road with the sand in it, and we have a road not much better than before.

I once belonged to a little grange that was organized in our township, and we met at two little school houses. The road between those two school houses disintegrated our grange. It was too hard work to get over that four miles of road, and the result was our grange broke up just on account of that miserable piece of road between the two school houses. Upon the remains of that grange a gravel road company was organized, and they put a toll road by there, and there are two results of that road to-day. One that the property along that road for six miles, while other farm properties have been greatly lessening in value, has increased from twenty-five per cent to forty per cent. Then too, an example has been set with regard to the use of gravel. That road came over a hill made of gravel and sand, and no one ever thought it could be made a good road. It was the hardest piece of road in our county. All

this company did was to screen out the sand and they had a perfect road-bed. That single example was worth more in the road districts than anything that ever happened before. And so I preach, with Mr. Steele, the value of missionary work.

Just how, by legislation, to get those examples of excellent pieces of road before the people, I don't know, but it is the one thing of all others most needed. If we can get a single line of good road in every county, in every state, we shall have the whole thing settled, because we shall have everybody with us.

Six months ago, if anyone had said, "You will be a bicycler," I would have called him—I would have said he was very much mistaken. In the twinkling of an eye I was converted to bicycling; and there are lots of people to-day that are opposing any change in our system of roads, who stick and cling to that old path-master system, that will be converted in the twinkling of an eye, if you can just make a good economical road near them. I hope that whatever legislation we have, we shall not undertake too much, but get some object lessons before the people. That one thing will soon convert them from the most pernicious system that ever was. It was good in its day.

One other thing has occurred to me with regard to specific taxation. Now, the objection you will meet everywhere, in submitting any plan to the people, the majority of farmers will object to any innovation because they are afraid of an addition in taxation. I have met that everywhere. Now, if you can adopt a system by which they will get good roads and not pay any more taxes (I mean outside of the taxation they never feel), if you could show them that in a year they will not pay as much taxes as they do now, they will be willing to adopt any kind of system. That is why I like the idea of a state tax that shall be paid by everybody, rather than one paid by the farmers themselves. While it is true that the more immediate benefit is reaped by the farmers themselves, still every man that buys a bushel of wheat or a pound of flour will be benefitted by better roads, for immediately when you reduce the cost of putting these products in the market to a minimum, you are helping every man that has to buy, and there is no injustice in making every man bear part of the taxes.

Farmers do not realize as they ought, one thing. We must, in some way, turn the trend from the cities into the country. I think that that is the most important question before our country to-day, how to do it. The gradual decadence of agriculture in this country has tended to throw the people into the cities. Let us get them back again some way; and there is no motive power that will be stronger than the building of good roads and making country life attractive. The one thing necessary is to make country life attractive to people and they will go there; and one of the most essential things is the interchange of visits and thought. And just as soon as you get good roads, you will bring people together, and country life will be attractive.

In regard to specific taxation; it seems to me, aside from this one thought, making everybody pay their proportion, there may be something in the English system of taxation, special taxes for those who use the roads most—every man who goes over the road with a vehicle, whether wagon, buggy or bicycle, it seems to me can pay something for the privilege of good roads, in addition to that great number of people who simply get an indirect benefit. I am interested in this discussion, and in this earnest endeavor to get better roads, and I believe that the engineers of this country must do more than any other organization, because you know how to make a road and make it economically; and it is because your services have been neglected that we haven't good roads.

THE PRESIDENT: We are glad to have these ideas that Mr. Garfield has so ably presented, and glad that the farmers are taking hold of this question. The engineers of the state have understood the necessity for good roads for a great many years, but whenever they have attempted to advocate anything of the sort, it was thrown in their faces that they were simply looking for a job, but now that the people themselves are taking it up, we can hope for some legislation.

I have believed for many years, that the great evil of farming life, was the want of those social enjoyments which the human mind must have. It is that which has been driving all the young men and women from the farm into the city, and crowding our cities, and which is sending so many of our

farmers' wives to the asylum. Get good roads, and as Mr. Garfield says, the current will begin to set back. Men living now on small wages in the city, will go back to the farm, and have all the social enjoyments that he would have in the city.

MR. STEELE: I do not come here to discuss this question in any sense, as an instructor of the engineers of Michigan, as to road building. I come before you as one to lift up a voice in the discussion of the question as a matter of public interest, hoping that whatever our discussion may be, it will be conducted in that spirit which shall make it the most valuable and useful to those in interest.

It may be claimed that the engineers are looking forward to do something in their own line: Very well, if we do not tend to our own business, I do not know who will do it for us, and I want to state my position, not so much in the discussion of the law side of the question, which has already been mentioned, as the practical side. We are passing through, or perhaps commencing, one stage of education in road making—not exactly in road making, but a preparatory course for road making. We are not ready even to make the roads yet. Hence, the first thing I would mention is education. Educate everybody—talk it over, publish all you can about it, keep it going; if you do not succeed at one time, strike fire somewhere else, and persistently put this subject before the people until they rise in arms, and accomplish what we are after. I would like to have the determination of every member of this Society so fixed in that line, that no matter what discouragements are met, mis-legislation, or wrong course of action, they will still go on and accomplish the desired result.

The first thing I would put down is education of ourselves, and people in general. You may start out in the state of Michigan to-day, and ask those you meet outside of the cities—I say outside of, because usually in the cities they find the advantage of nice streets and pavements, which the rural communities do not have and appreciate, or think they cannot have, and you make a note of those men you converse with, and you will find the difficulty is, that they are opposed to any movement at all. They are afraid of everything—do not want to take a single step forward in this matter. You may present

an amendment to the constitution to-day, in the way of bringing this result nearer, and they will vote it down here in Michigan. Why? Because the people are not educated yet to see the necessity, or they do not fully understand the rut into which we have gotten. The education then should be begun of the people, broadening their views through our papers, through every channel, through the societies; and let me say right here, I have understood that some of the societies, or one of the leading organizations of the state have cast a reflection on the wheel men, saying that they were the prime movers in this work, and that the subject was not worthy of our attention, because of their moving first in the matter. Now this has come to me through good solid, straight-forward farmers. Wonderful, isn't it? I said to the man who told me that, "I would give credit to the d——l, if he only started people thinking about the system we have. I do not care who starts the subject if the ball is only set rolling."

Now we have another phase on this subject, not already mentioned. That is the need of the engineering profession to be prepared for the emergencies which they constantly meet. It has been suggested that our schools be transformed into great classes of students learning how to make highways; that we have schools of technology, with a special department which shall have professors etc., to illustrate how to make a good road. Now, I have no objections to raise for any such course that will more enlighten the people, because I have already planted one stake—my educational stake, but I say that it is assuming too much to claim here, in this early stage of the construction of roads in Michigan as they should be constructed, that the engineering profession that we already have, the gentlemen that I see before me at the present time, part of them, that we are not capable of taking the responsibility of road construction without more special education on the subject. It is rather a laughable situation, when we know that you gentlemen are engaged in the construction of all sorts of engineering works, railroads, bridges, tunnels and river improvements, and all classes of engineering work which tax the highest skill, yet it is suggested that the engineering profession needs special schooling to make a highway. I deny

the imputation. Is it not a fact? I will assert boldly that the engineering profession is able to take care of the highways, if only afforded the opportunity.

The next stake that I would plant most substantially and thoroughly, is for the location of the road. After having arranged all our preliminaries—how we are to get our money and change our laws—the next thing to do is to know how to locate the road, and that is just the very thing that we have not known how to do. I want to give a few of my experiences in locating roads.

In 1867 I surveyed the state road from Houghton to Midland. It was then a wilderness. We had to carry our provisions on our backs. Our whole expenses were to be paid by the counties through which the road was laid, and the bill would go before the board of supervisors. It started through Traverse county, and the county of Grand Traverse had to shoulder all the bills, as the others were uninhabited. It will be plain at once that the expenses ought to be kept at a minimum. When we came to a range of hills, we did not know which way to go without great inconvenience, but the order of the commissioner came, "Keep your line." We did so, and the state went to the expense of building a road over the hills, grubbing out the forest trees; and an almost impassble road it was, when created. After awhile a lumberman came in. He made a road right around the hills, and in about five miles came into our line, and the consequence was, he had a splendid road, laid on a grade that could take the immense loads that the lumbermen haul.

A few months ago I was called to lay a highway. I went south over an easy grade, and came within 133 feet of a quarter post. The petition was to go to that quarter post, and then turn east on the quarter line. The commissioner was very careful to require me to go to that quarter post. That stood upon a hill as high as this building; it was all a man could do to ever get up or down. But he wanted me to lay the road up that hill to the quarter post and then turn and go down. I said, "Why not lay it around here?" "Oh, the petition didn't call for that; I couldn't do it." Well, after arguing that question with the help of some men who were residents, he did finally decide to locate it around

the hill. I merely wish to show the folly of locating roads under our present system.

Location having been established, the next thing is distance. Distance has been cutting the first figure; it should not be so. We have been trying to shorten the distance, irrespective of grade or anything else; the proper plan is to transpose. Locate your line without reference to distance. First get a good grade, and then make it as short as possible in that grade. There are the two systems—the gist of the whole matter. We have been neglecting the one and observing the other.

The next thing to do in this state, is to have some one authorized, or some board of commissioners authorized, to re-locate roads that are already located or badly located—have authority to step right into a difficult place and say, "Here, gentlemen, this road is going on a grade around this hill, and you may say what you wish; we are going to take that land and put a road there. We are never going to spend another dollar on that hill."

The next stake would be on construction. We have been transposing; we have been trying to construct roads on bad locations. If we have good location first, we may make allowance for poor construction; but if we have a bad location, no good construction can ever accomplish what we want. I know of hills that they have put hundreds and thousands of dollars upon, and there are the hills yet; and I can stand upon the track and, without an instrument in my hand, mark out where I could locate a road to good advantage. I say every man ought to stand right up and put his shoulder to the wheel and say, "Stop, we have gone far enough!"

Another thing we are faulty in; we are not persistent in construction. We do not make it continuous and constant. We make a little effort during the season of the year when it is most convenient to make a road, and then drop it. I say, adopt a plan which will give a force upon a road similar to the way in which Mr. Sears puts a force of men on his railroad. Have a force of men to keep the road in order, to dig ditches so the water will run off. You know of many places where five minutes' work would save a great mud hole, if the work were only

done at the proper time. We ought to adopt a system which will give us continuous supervision and construction of highways, by a set of men specially employed for that purpose.

Another difficulty is this: We cannot carry our labor in one district over into another. Now, Traverse City, in which I live, is so situated that its highways are generally upon a level plain—a sandy plain needing only a gravel covering, and then we have an excellent road; but we cannot step over into our adjoining towns and spend any money; and if they have a hard place which they are unable to level down or improve, why, we have got to go over it. We cannot do anything to assist them. What I mean is to have it so arranged that appropriations of money can be made on roads, perhaps clear through the county or running out from the railway stations or county seat.

Another thing which we should encourage is the handy curve already mentioned; and in locating roads, to secure easy curves. Did you ever notice how easy it was to keep a road in repair at a corner where an easy curve was turned? Almost every one that I can think of, where an easy curve is made in the road, always has a good track. I want to enforce that idea and apply it in the location and construction of our roads—easy curves instead of abrupt angles.

Another difficulty in road construction is that the engineer is entirely eliminated from the question. We have been going on the plan that we did not want any engineer. We get him simply to give us a sight through a compass and then let him alone. I had no rights on that day when I had the confab with the commissioner; I ought to have kept still and let him locate that road over the hill. I say that we have eliminated the engineer, and I want to rise in my might and say, "Let us come up and take the fort." It is time for the people to rise and demand recognition. We have been absolutely kept out from first to last. The application for the location of a highway—the authority in that is confined exclusively to the highway commissioner. There is not a man in the state of Michigan that can say "no" to the highway commissioner. His location cannot even be altered by the board of supervisors. There is not a man in the township

where he lives that can say anything; there is no check upon him. Isn't it a good principle, when you have a man handling money, to have someone else to keep check upon him? I think so.

One more point I want to raise, and I am through. It has been suggested by one of the regents of the university, or one who has held the office of regent, in my conversation with him on the train coming to this meeting, that it might be a good plan to so arrange our engineering courses in the Agricultural college and the university, that a good many of these things that we require of an engineer could be accomplished through the information of these young men and their able tutors. That is, to put into actual practice the ideas that they are taught there, and let them to some extent, through the years to come, go out here in the state of Michigan and do this work. This gave me a new idea, and possibly it may be of some value to adopt a plan by which in the making of estimates, in the location of grades, setting of stakes, watching construction or carrying forward of large contracts, that these men can give us valuable assistance without extra expense. They would be pursuing their instruction under the guidance and control of their professors.

MR. TEED: We built a road last year; and I thought I would tell you how we built it and what it is worth. But as Brother Steele remarked something about the county surveyor it made me think of something I want to say. I want to tell you about the county surveyor in our county. I was away last week, and when I got home, there was a great rush and hurrah. They wanted to find the county surveyor, and everybody I met told me the supervisors wanted to see the county surveyor. I went up; and the way they shook hands! I got an idea in my head that I was the most important man in the county. They stated their business and we transacted it in a little while. But this idea still clung to me, and I said, "I have been county surveyor for twelve years, and when I serve this term out it will be fourteen. Now," I said, "I never asked for anything yet, and seeing I have to keep the records, and seeing I had to buy the safe to keep the records in, and had to rent an office to put the safe in, that I would ask the county to pay

one-fourth of my office rent." They almost fainted away, but when they got over it, they began to laugh; and when they did, I said, "Gentlemen, it wasn't anything but a joke."

Well, we built last year about eight miles of what we called a boulevard. Of course, as it was built outside of the city, the money was all raised by private subscription. It was built around the shore of the lake. The only soil was this light sand. We surveyed the road just as if for a railroad so far as crooks and curves were concerned, but then the question was how to get the gravel? Now, it has been suggested by one or two persons that in a great many townships there wasn't any gravel, and in a paper read this morning, a means was suggested to get the gravel. Now, the gravel over half of that road was hauled ten miles and it did not cost much. One of the logging roads, extending out of the town ran through an excellent patch of gravel. It had gravel and clay, just the right amount. Now, they took light iron and laid right along this track, and went up into the woods, hauled the gravel down and dumped it. When they got the gravel the whole length of the road, they pulled the track up, and put the gravel in the middle. This is a good gravel road, and there was no gravel to be gotten within a good many miles, and yet it was not very expensive. When we built on the south side of the lake, they adopted the same method, so far as putting it on the cars, but there was a gravel pit right at hand, and they didn't sift the gravel, one part gravel, two parts sand, and they fixed the road on the south side of the lake. But that never has packed and never will pack if left alone; and they will have to fix it just as we re-gravel our roads in town. The way we did that, we got the road-bed prepared all right, and then spread that over with three inches of clay. We then put on four to six inches of of gravel, according to the amount of travel, and if the sand was sifted. Of course, if sifted, it would take less gravel and less clay; first three inches clay and then five or six inches of gravel. That packs down and makes a road as hard as a stone. We found it cheaper to put on the clay than to sift the gravel.

The way we came to do it was this: The people that built the first streets in the town said, "We want to make this road

so that the rest of the people will catch the idea and build their roads right. We drove stakes twenty feet apart, up the line of the street, and four rows of stakes—drove them down to where we wanted the sub-grade, and then put an assistant of mine to work right along with the contractor. He put strips three inches wide and filled the clay up to that. Then he put small stakes down, that would come to the top of the clay, and put on his strips five and six inches wide, and then filled the gravel to that. When finished, we had just the amount of clay and gravel that we needed. This year the question came up of building some more roads, and some of the council objected. They said, "We have a city surveyor; let him stake it out and take his levels," but they didn't think it would pay to put a man on there to work right along with him; but, of course that question was argued, and the system we have is to have this man work right along with the contractor. He sets the stakes in the first place, and has them to work from, and puts just so many inches of clay and gravel.

Now this boulevard—the part that didn't work. We have got to take a scraper and go through, and throw the gravel out to the sides, and then go and put that clay in, and then throw the gravel back, either with the scraper or by hand.

MR. HODGMAN: I want to make a suggestion: We were to leave the question of construction until after we had the papers on that subject, and instead of discussing the question how to make roads, first get at the point of how to improve the laws. I would suggest that we appoint a committee of three to collect the points upon which we seem to be agreed as to the way our laws should be amended, and to collect and codify them.

MR. APPLETON: I would like to know if the gentleman's idea is, to have the committee collect and codify from the whole mass, and submit to this meeting before it adjourns? Won't the time be a little short?

MR. HODGMAN: I don't know as any committee could, during this session, codify these statements. My idea was, to select the points, codify them—those that we seem to be agreed upon, print them, and send out to members who are

not here for their suggestions, and then place it before the proper authorities.

MR. CHURCH: I wish to say just a few words that Mr. Steele's remarks suggested: We sometimes succeed in getting the commissioner to locate the right road, and then find in a short time, somebody's land is taken. He works by some hook or crook to get the commissioner to take up that road and put it over some hill, and it is done. A good location and money as well, lost. When the road is well located, it should be out of the commissioner's power to easily move it.

MR. STRONG: As to the change we want made in the law, it seems to be pretty well agreed, and it is the opinion of those who have looked the matter up, so far as the law is concerned, that the probabilities are, that we will not be able to make any radical change in the near future. Isn't it wise then for us to try and make a bridge for ourselves? In this matter of roads, if it is probable that we cannot accomplish what we would like, isn't it wise for us to study more particularly on what we can do at the present time to improve the system we now have, so as to make it answer temporarily the needs and purposes of the public generally and the farmers, and yet flatter their prejudices, and yield to the opinion which probably will be the opinion of the state and of the legislature, so that we can accomplish almost what we want at present, and some day, accomplish all that any of us imagine.

It is possible for us to improve the system we now have, and I have simply given this as a matter of suggestion.

MR. HODGMAN: I want to speak a few words more, regarding the point I presented this forenoon. It was right in line with the argument presented by the last speaker. I believe that we are to be compelled to use our existing agencies to a great extent; I myself have very grave doubts as to the results of putting any constitutional amendment before the people. The people in the state of Michigan have got in the habit of voting down constitutional amendments. I believe, that under the plan I presented, we can have our road laws improved, without changing the constitution. We have tested for years and years, the plan of the mill tax for the support of our public schools; I believe a similar tax for the support of our high-

ways can be made by the legislature. I think without any constitutional amendment we can put an end to the present want of system of work on the highways. I don't know of a man who would not say, that with money to work on a road, he can do four times as much as is done at present. I believe the people of Michigan are willing to abolish the present system of laboring on the highways; our legislature can levy the tax without a constitutional amendment. I think we can make use of our present highway commissioners, and by having a Board, for the purpose of reaching the roads that concern the people of more than one neighborhood, make at least a good beginning without any constitutional amendments. Now, the best thing I know of in the way of an education, is a good piece of road in a neighborhood. I think we can start the matter right now, and my plan, I think, is feasible.

MR. BAILEY: I move that a committee of three be appointed to draft a bill to be presented to the legislature. I think that is the right thing. We might talk for four weeks or four years, as engineers, and the gentlemen sitting up in that big building to-day, if we were to present a bill, would sit right down on it.

Now, I move that a committee of three be appointed to draft a bill to be presented to the legislature, but that bill before it is presented, should be submitted to every member of this organization for his suggestions.

Another thing—I propose that we have two engineers and one granger, and we have a granger right here. He represents a good many thousand of the best farmers in the state of Michigan, and I know it. I would like to see one granger put on this committee, and two good engineers of this Society.

MR. APPLETON: I was talking with Judge Black of this city on my way home from this meeting, and he tells me that so far as the constitutional convention is concerned, that some of us have thought might be held, that it cannot be, and I believe he emphasized it by saying, that there was no question about it at all. The vote in the state must be in proportion to the vote cast for the members of the legislature, which it in no way approximates, and I think his view of the case is entitled to weight; therefore in view of that I think it would be unwise

for us to spend a great deal of time upon a measure that will need an amendment to the constitution. I think it will put it too far off, and so far as the road commissioner is concerned, I am perfectly willing to leave it to the committee.

It has becn suggested by some one, that a committee of three is hardly enough, but the difficulty I have always found is, that the committee never all come. I think perhaps five might think of more good than three, if they would work, but if we were to talk here for ten years, you would have to leave it to a committee to suggest to the legislature, and that seems to be the only way to amend the present law. Whatever you do will have to go in the shape of amendments to the present law. I haven't a particle of faith in the ordinary road commissioner. The township of De Witt I think, appropriated the sum of $500 for the benefit of the roads, and they specified two particular pieces of road that should receive the benefit of the $500, in sums of $250 each. Of course, the commissioner went on and expended these sums. The only difference now, and before the commissioner put his $250 on the piece, is that it is infinitely worse now than before, because he drew worse stuff on the road. The people of the township are disgusted, and probably will never appropriate another $500 to be fooled away.

But I think a committee will have to be employed to select the most harmonious suggestions and present them, whether to each member or not—perhaps that is the best way, but I am certainly in favor of the plan, and I think the allusion to Mr. Garfield is good. I think perhaps we might adopt the suggestion made, to have five members of the committee, and thoroughly impress upon them that they should meet with the first named who may be the chairman, and then look this matter over, and get it before the present members of the legislature at as early a day as possible. So far as this road making is concerned, I know some of the best engineers who are the poorest road makers.

MR. STEELE: I think it would be decidedly out of place for the Michigan Engineering Society to go to drafting a bill to present to the legislature; but it would be very much in our line of work to offer a suggestion, either to the proper com-

mittee of the legislature or to the committee on public highways, which would embrace our ideas as practical engineers interested in this subject, in a brief statement of what we believe would be for the interest of all concerned. And I certainly would not reflect upon the ability of the members present, by saying that they are not able to draw such a statement of their views—I believe in going at it, doing it, and having it done. There is no reason why, before we adjourn, if we keep in session part of to-morrow, that we cannot do it.

I make a motion to this effect; that this Society before it adjourns, shall, through a committee, appointed by the chair, consisting of five members, embody its opinion on the subject of road laws, and present it to the highway commission, or to the proper committee of the legislature, as they may deem best.

MR. SELLERS: I support Mr. Steele's motion.

THE PRESIDENT: The question before the Society is, shall we, before we adjourn, appoint a committee of five members through the chair, to draw up an expression of the ideas of this Society with regard to the road laws, and present the same to the legislature?

MR. SELLERS: Are we as a Society, sufficiently well founded in our own minds, to have this committee, in so short a time, suggest anything but what would be susceptible to a great many amendments in the legislature?

MR. HODGMAN: I think we are very nearly unanimous on the important points. I have been greatly surprised that people coming here from different parts of the state, who never had any correspondence with each other on the subject, seem to be so nearly united, and I think great good will come out of our getting together and appointing this committee.

THE PRESIDENT: Are you ready for the question?

The motion seconded and carried.

THE SECRETARY: Mr. Appleton referred to bad work done by a highway commissioner in Dewitt. The other side is shown by the following report, and remarks by T. O. Williams, which came into the Secretary's hands since the Annual was in press and is inserted here in connection with the discussion:

HIGHWAY COMMISSIONER'S REPORT.

ALLEGAN, April 3, 1893.

To the Township Board of the township of Allegan, County of Allegan:

The following is the annual statement of the commissioner of highways, of the township of Allegan, in said county of Allegan, for the year ending April 3, 1893:

The improvements which have been made on the roads, culverts and bridges are as follows:

Expense of building culvert in Rossman's ravine, size 66 feet long, 10x12 feet inside	$1,329.06
Expense of building Kellogg culvert, size 66 feet long, 12x12 feet inside	1,698.92
Repairs on the Maskey culvert	45.80
Repairs on approach to Allegan bridge	68.21
For plank for Littlejohn bridge	55.45
Repairs on Eagle foundry bridge	11.15

South Watson road—three-fourths mile, graded and graveled at a cost of $459.63 over and above about $500 worth of team work donated.

North Watson road—about one hundred rods graded and graveled at a cost of $424.09 over and above $200 worth of team work donated.

Road running north from Greitzinger corners, one-half mile graded, eighty rods graveled at a cost of $477.33 over and above $200 worth of team work donated.

Road running east from Wetmore's one-half mile, graded and nearly graveled at a cost of $149.68 over and above $200 worth of team work donated.

Monterey road—sixteen hundred feet of road graded and six hundred feet graveled at a cost of $542.79

Dumont road—one hundred and forty rods graveled and other repairs made at a cost of $252.15 over and above $300 worth of team work donated.

Cummins road—work done at a cost of	$175.11
State road—work done at a cost of	116.45
Job let	400.00
Cheshire road—job let for	182.50
Saugatuck road—repairs done at a cost of	49.16
Mill Grove road—repairs done	34.44
Kellog hill—repairs done	71.56
Otsego road—repairs done	9.93
Sherwood & Griswold for lumber	72.04
Turner and Renihan—for hardware	29.83
Roscoe Ellis—to apply on job on Wilson hill	50.00
John M. Heath—for plow fixtures	7.64
Thomas Stewart—for plow points	3.45
Snyder & Brown—blacksmithing	1.50
Road scraper blade	8.00
For tile used in the various districts of the township	287.72
Total expenditure	$7,013.62
Amount overdrawn	13.62

More money was necessary to be used than was raised at town meeting, which was $7,000. I would recommend building a culvert on the Dumont road near William Barnes, as the bridge there is in bad condition.

I would further recommend there be $3,000 raised for highway purposes to be used on the roads, where the people will donate sufficient team work to draw the gravel.

CLARK COLLINS,
Highway Commissioner.

Roads in our town are so well built that the item of repairs is very light. The first permanent road, built about eight years ago, has sustained an immense travel and, with the exception of a few loads of gravel placed in the worn out places and a general surfacing up with the road scraper, there have been no repairs.

The roads are very permanent with 8″ to 12″ of gravel on the subgrade. The per cent of grade is established by the township board. The people are very well satisfied with the returns from the money, and at this last town meeting they raised $3,000 by vote, and the town board have the right to raise more and probably will, so as to make two or three miles of road this summer.

THE PRESIDENT: You are all aware, that some time ago, Governor Winans appointed a committee to investigate the subject of road laws, and they have made a report which must largely govern our deliberations. I am pleased to know that one of the members of that commission is present, and we would be very glad indeed to hear from him, especially with regard to the defects which the committee found to exist in the provisions of our constitution.

MR. KINNANE: I feel assured that anything I might offer would not be of much interest to this Association, along the line of road making. Through the courtesy of the Secretary of this Association, I have come here for the purpose of observation and reception, rather than to offer any exposition along the lines of the general subject. I have, however, some views in regard to the legal obstacles of the question —or the problem, as it now stands.

Together with the other two members of the committee, of which I had the honor to be one, the legal aspect of the matter was considered at several sessions, and the two great requisites seemed to be, that there shall be a somewhat revolutionary system of legislation adopted, and somewhat after the fashion that the board of supervisors took. The several counties are hedged in by constitutional environments, so that it may be said, that the whole system of township commissioner and path-master is hedged in, so that it is practically impossible to make much of an inovation upon the present system, without a constitutional amendment.

You will recall, undoubtedly, because it is a matter of special interest to ourselves, a case that went up from Saginaw county, where an attempt was made to lay out a system of expenditure on county roads, and it was held that it was an invasion upon the prerogatives and the constitutional power of the highway commissioner, and the legislation was held invalid, and the tax levied in consequence not collected.

There was a commission constituted up in Bay county—what is known as the "Stone Road Commission." They have built, as I understand it, nearly fifty miles of stone roads, and made excellent progress; but their system has only worked because of practically unanimous acquiescence, because it stands upon the same basis that the Saginaw scheme stood.

So I see that the first obstacle which confronted us, was the necessity for a constitutional amendment that would do away with the powers of the present township highway commissioner. In other words, that would give the legislature power to accomplish that. Of course, we did not go beyond a mere general statement, for it is simply a matter of engineering skill to carry out the details of any plan.

Our idea was this, that a system of county roads should be laid out—that is to say, the main highways, extending to and from the county seat—that it should be under the control of a board of highway commissioners, to embody five, in our proposed amendment, five commissioners to have general power to lay out and discontinue and do everything else in the way of road making upon the main highways of the county that was necessary; and also we embody the idea of special assessments to some extent.

That is the way the matter stands. If anything is done in the way of a general plan that can be developed for a period of years, upon some enlightened scheme of engineering, it seems to me that it will be absolutely necessary to have a constitutional amendment in order to do it. You cannot get rid of the arbitrary power that is given the present township officers now without it. You must draw the teeth of the highway commissioner's power as they now are, before you can accomplish anything else.

I have felt some encouragement from what I have heard to-

day. Coming with the idea of listening, I believe I have more practical information upon the general subject than I have been able to get in some months of desultory reading; and what I hope for now is this (and I believe I speak the sentiments of the commission), and that is that possibly through the interest of the engineers and the bicycle clubs, and such others as may take a general interest in the subject, that a constitutional amendment may be submitted and may possibly be carried, although that would, on the face of it, look like a bad probability. The hope of the whole matter would lie in its being pushed in special interests. It has already been intimated that the farming community, for whose special interest the whole matter will ultimate, will be just the ones to get the idea in the first place that there is a possibility of extra taxation, and when they have that idea, you cannot dislodge it, and there is no room for another; and if they vote at all, they will vote it down. So there is abundant opportunity and neccessity for missionary work, and an intelligent discussion of the matter from a practical standpoint will possibly facilitate the passage of the amendment. If the amendment is passed, there will be a bill introduced so that legislation may be had at this session; after the constitutional amendment is passed, if it shall be passed, and the amendment that we have submitted or something in the nature of it, will clear the way for such legislation as will facilitate and make possible an enlightened plan of systematic road building that will be somewhat of an innovation on what we have been doing, under the path-master system.

I tender my thanks to the Association for their courtesy.

THE PRESIDENT: Do you know whether this proposed amendment has been introduced into the legislature?

MR. KINNANE: It was submitted with the message of the out-going governor, and the report now is in the hands of the proper committee, and I think nothing has been done. It will be submitted without doubt. The amendment covers quite a little ground, and it seems to us necessary, in order to accomplish needed results.

THE PRESIDENT: It seems to me that one of the most effective things this Society can do, will be to pass a resolution properly drawn up, petitioning the legislature to submit this

amendment, or something, such as their judgment shall dictate. I am confident that these gentlemen have examined into this matter thoroughly and know just what they are talking about; and so long as our constitution is in such a condition that we cannot modify our present system, it is a waste of time for us to talk. I do not believe we can ever get good roads so long as we have the present system. You cannot get men fit to build roads, to serve for $1.50 or $2.00 a day.

MR. ALBERTSON: It would seem that it would be necessary to have gravel beds in order to make very much improvement on the roads, whether under the present system or a modified one. And wouldn't it be well to provide that the township could own gravel beds, with a right-of-way to them, and the right of condemnation? That can be done under the present system.

MR. KINNANE: I presume that can be done.

MR. BAILEY: The words just spoken are good. Two years ago I had occasion to look up the road law, and I will simply say here, we haven't a road law in the state of Michigan. If there is any gentleman present who has been highway commissioner, he has probably taken his level and gone on to some hill and set his grade stakes, and about the time he got his team there, he ran against a stump; nothing more nor less than, as the gentleman says, a farmer who had got an idea it was going to cost him something, and away he goes to the county seat, gets an injunction and a man with a high collar on, and I have to—whoa! This is an actual fact, and it has actually transpired within eight miles of this big city.

As the gentleman says, if we have a road law, it should be a radical one. I tried my best to get that right-of-way. I could not get it of him, and I say to-day that you cannot work the public highway in the state of Michigan without laying yourself liable to charge of trespass, and they will sustain an action against you every time, unless you get the right-of-way in proper shape.

I had occasion to look up this law with as a good lawyer as the state of Michigan affords, and he said that under our present law it seemed impossible to do anything upon the public roads. And if the people vote to revise the constitution, I hope

whoever is appointed will see that a proper road law is put in, so that if I am highway commissioner again, I can level and grade my roads. I have been path-master in my district eleven years, and I never worked on a road without setting grade stakes, and the wheelmen always like to turn into my house and get a drink of water at my well; they want to shake hands, and they say, "Mr. Bailey, who built that road along here?" I have made a trotting course there, a mile long. It was used and is used for a trotting course, and it is the only good piece of road between here and Eaton Rapids, if I did help to build the state road.

If we can get the grangers to move in this respect, they will carry an immense amount of influence towards getting what we want; and if we can get them waked up to this idea, we will get some help, because they are the wealthier part of the farming community. They are the lettered part—men who read and study.

Another thing I wish to speak about: why I spoke of Mr. Garfield. He belongs to the state horticultural society. That is a large factor. This society, or the off-shoot that I belong to, for the last five years has talked nothing but roads, laws for better roads, and the ways and means to make them so. You see, the people are getting waked up about roads, and I hope this thing will be brought to a successful issue. I do not think anything will be done this present term, but I do think when our constitution is revised, and the necessary incorporations made, that we can have good roads.

THE PRESIDENT: Any further remarks on this branch of the question, The Road Laws? If not we will proceed to the papers on Road Construction.

MR. STEELE: In the discussion of this subject, we have been governed by the sole idea that we were going to make a dead sure thing of a new plan in the system of highway construction. Now, from the report of this gentleman, we are led to understand that there is an insurmountable obstacle in the way. It occurs to me that I would like to call upon any gentleman present to give his views, if he has any, or turn it a little the other way, ask if any gentleman present knows why the legislature of Michigan, now in session, hasn't authority to pass

a law to restrict, enlarge or control the present highway commissioners of the state of Michigan?

MR. APPLETON: I know no one better qualified to answer the question than George E. Steele, of Grand Traverse. He has been looking up the law a little.

MR. STEELE: I have read enough to keep out of jail so far. But I am one of the kind that doesn't believe in backing down. When you get started on a right thing, or a thing that is going to be right, push it on. I am sorry to see that Mr. Kinnane has gone; I wanted to ask if the commission had considered that question, whether in the event of failure to pass such an amendment, they had considered this question as an alternative, until the other can be brought about, whether we could not make such a change to great advantage.

MR. HODGMAN: I think he made the statement that we could. I wanted to suggest that what I said this morning was with that directly in view. Very likely we shall have to keep the highway commissioner, whether we want to or not, and I made suggestions for the purpose of controlling the highway commissioner. I believe that the highway commissioner is just as much subject to the acts of legislature as any other member of the township or state. That highway commissioner can be controlled I believe, and my whole scheme had that in view. I believe we can put the whole thing right through our legislature without changing the constitution at all. If we get a real good man for highway commissioner, the chances are the people will continue him in office. My whole scheme is with the idea in view of the constitutional amendment failing, and that we should do the best we can with the means at hand.

MR. RANDALL: I think that every session our legislature has been trying to control this same highway commissioner. I believe it is about all lost. I find a great many things in our present road laws, very good limitations on this highway commissioner, all having no effect whatever. It says among other things that the ditches shall be at least ten feet from the center of the road, and that improvements of the roads shall, as fast as practicable, be made with gravel. It goes on to say a great many other things, and if the commissioner followed the law, pretty good roads would result; but this road business is under

the control of the highway commissioner, and when we start to institute any changes, we fail every time; and when we enact laws and try to control him, he does not take the trouble to read them.

We had some trouble in a township adjoining us, where they were going to build a road to our town. We were very much interested in this road, because we wanted the people to come down and trade with us. I asked the commissioner about his specifications. He said, "I am going to turn-pike that whole business. I am going to have it fourteen feet from the bottom of one ditch to the bottom of the other, and have the ditches two feet deep below the natural land, before it is graded." Well, we got to talking about it. We didn't expect to make any suggestions; we thought, though, if he built such deep ditches as that and then drew up his grade, it would make the road pretty narrow, and we thought it ought not to be less than twenty feet wide.

"Well," he says, "I cannot help that, and I think I know how to do this business." It happened that a few of us fellows got around and said: "Mr. Commissioner, there is the law, and if you don't follow it, we will make you sorry," and we got him to change his specifications. Not because the law was there, but because there were a few determined men. I have no faith in this highway commissioner system. Let us have some good roads; I do not think we can do away with the commissioner, but let us have a county system in addition. The gods themselves cannot take back their gifts; we have put this matter in the hands of the road commissioner, and we cannot take back the gifts we have given him. Let them have their township roads, and have them just as muddy as they can, but let us have some county roads.

MR. F. H. WILLIAMS: I think the subject of this discussion has come down to two points—education and legislation. I believe that under our present system, we can go on and improve our roads, and make good highways. I know it can be done. In our own township, one or two men who were up in the business, and knew what good roads meant, insisted we should have half a mile of good road. That one half mile was built. The next year, the farmers of that community and the

business men, turned into our township meeting and voted $1,000 for the further improvement of that road. It was done. Next year we had a vote of $2,000, and during the last six or eight years, the appropriation has amounted to between $20,000 and $25,000, and now we have twenty miles of good roads. Put a good road beside a bad road, and the difference will be appreciated. If you will try that once, yon will see the good results.

How can we control the highway commissioner? Simply in this way. Elect a good man. Second, have him required, before he puts one cent of money upon a road, to have a survey made by a good engineer. After you get the plans and specifications, have the commissioner follow them out, place a penalty that he will suffer if he does not, and I think under that plan, and with that system, we can make what we already have, answer. What cannot be cured must be endured, and I think we have a system which we can adapt to good roads, and get good results.

THE PRESIDENT: If there is nothing further to be said on the subject of road laws, I think we had better proceed to the reading of papers on road construction.

STONE ROADS IN BAY COUNTY.

H. C. THOMPSON.

In 1880, the board of supervisors conceived the idea that the highways should be improved permanently, and set themselves at work to formulate a plan for so doing. A proposition to raise one hundred thousand dollars on the bonds of the county was submitted to a vote of the people, and was carried. Committees were appointed by the board of supervisors to visit localities where permanent roads had been constructed, and work was begun on several of the main thoroughfares.

There being no suitable material in the county for constructing the roads, stone was procured in Ohio, and conveyed by boats to the Saginaw river, where it was placed on docks and drawn by teams to the respective roads.

The Ohio stone, not proving satisfactory—being too soft, a better quality was obtained on the shore of Lake Huron at Bay Port, where it was loaded on cars and conveyed by rail to its destination. Considerable gravel was used in the construction of the roads at different times, and this was procured from gravel beds near Mason. All the material used had to be imported, thus making the cost considerable; but the result of having good roads at all times of the year is shown in there being a uniform price and market for all farm products, and never at any time is there a scarcity of any of the necessaries of life, on account of bad roads.

The soil is a sandy loam, and the surface practically level, raising about three feet to a mile from the level of the bay, which affords sufficient grade to convey surface water through artificial channels. The first object to be sought was drainage, and this was accomplished by constructing suitable drains on both sides of the grade. An excavation twelve feet wide, and about one foot deep was then made on one side of the grade to receive the first layer of stone, which was composed of the larger stones, laid flat with edges close together. This foundation would averange four inches in thickness. Upon this layer was placed stones of smaller size, and in the early part of the work the surface was made smooth by pounding with hammers, until the stones on the surface would be about one and a half inches in diameter. Later, the top dressing was put on entirely with crushed stone. Gravel was also used as a top dressing, but this was so easily displaced that the crushed stone was adopted. There was no roller used in compacting the stone or the sub-grade. On this account a great many of the stones would be displaced by the traffic, and it would require some time before a uniform surface would be made, and this not until the ruts made by the wheels had been filled by raking in the loose material. A road machine or scraper has been used to do this work, with good results. The first few years the practice was, to make the width of stone twelve feet, but later nine feet was adopted, with a margin of two feet of earth on one side and eleven on the opposite, making a road bed twenty-two feet wide.

This has proven to be of sufficient width for all purposes. The surface of the road has a crown of one foot, and the stone work a crown of four inches which soon wears down level, and after about three years use, requires a top dressing of fine broken stone, to fill up uneven places. The depth of material laid loose, was twelve inches, but when compacted would not be more than eight inches. The stone costs delivered on the railroad, about $5.80 per cord, which would lay about three rods in length, The earth work, hauling and laying the stone was let by contract to the lowest bidders, and varied from $1.60 per rod where the material did not have to be hauled more than one-half mile, to $5.50 per rod where the distance was five miles.

The act authorizing the issue of bonds, also provides that a sum not exceeding two mills each year could be spread upon the cities and townships, included in the stone road district, and the money thus raised, about $30,000 annually, could be used in extending and repairing the roads, which has been done each year, until there are at present, about fifty miles in good condition. The supreme court has decided the tax to be unconstitutional, in that a tax could not be levied in city or town to maintain roads in another municipality. This will end the further extension of the roads, and it will be doubtful if the several townships through which the roads extend, will be able to bear even the expense of keeping them in repair, the cities having paid about nine-tenths of the whole amount expended.

The average cost has been about $6.00 per rod, and I think about thirty cents per rod would keep the roads in good condition.

MR. ROGERS: This question of cost, is something the farmers are very anxious to learn about.

MR. BAILEY: My paper has had all the wind taken out of its sails. If anyone would like to know how I would make a good road, I could tell them in about five minutes.

MR. STEELE: That is what we are here for. If you can tell us in five minutes, we would like to hear it.

HOW TO MAKE A GOOD ROAD FROM THE MATERIALS AT HAND.

M. H. BAILEY.

First survey, level and cross-section the road, noting carefully every water course and depression where water is likely to run or stand. Draw a profile of the work, giving exact grade line of road-bed, depth and width of all cuttings and fills, grade, depth, and size of all water courses, culverts and sluices, natural and artificial, that will be necessary to properly drain the road-bed. Cross-section the road every sixty-six feet, setting stakes for outside of cuts and fills.

Get the right-of-way, if you can, for the improvement of the road and water courses, from the land owners. If you cannot get the right-of-way from them, the statute points out the manner of proceedure.

The right-of-way secured, you are ready to commence work. First excavate your ditches and clean out the water courses. Put in the culverts and sluices; make the cuts, fills, culverts and water courses exactly to agree with the profile; call on the engineer to examine the work and see that it is correct. If pronounced O. K. you are now ready to commence work that twenty-three out of twenty-five individuals will call you a —— fool for doing. They don't know that earth is a sponge and must be made very fine in order to pack down hard. Have a good plow that will easily reach a depth of ten inches. Set it so that it will get there; put on team enough to go along easily. Start in the center of the road; start a subsoil plow in the same furrow that will go six inches deeper than the surface plow, so as to thoroughly break up the road-bed sixteen inches deep. Back-furrow in this way until you have a road-bed broken up thirty-four feet wide. Have hands enough to pick out all the stone, depositing them on the side of the road where they can be handily got by wagon or stone boat, to be placed at the foot of the embankment or where they will be out of the way and not likely to get in the track again. Hitch two good teams onto a good forty-tooth

spike harrow and harrow the ground thoroughly, picking out all the stones. Back-furrow the road to the center again with furrows eight inches deep and six inches wide; back-furrow the road-bed thirty-two feet wide; harrow thoroughly and pick out all the stones as before,until it is as fine as a garden bed. Plow it again commencing three feet out from the center and back-furrow thirty feet wide; harrow it again thoroughly. You are now ready to use a good road grader. Set the ditch end of the blade as low as you can and the road end as high as you can. Go over the track twice, the last time only cutting off the knolls and hummocks that were left the first time over. Clean out your ditches with hand shovels. Now set the blade of the scraper with the ditch end an inch lower than level and the road end an inch higher than level, ditch wheel of scraper three feet from center of ditch. This will level the earth very good. Now set the scraper blade level and square across the road, and drive in the center of the road. This will leave a ridge at each end of the blade; set the blade so as to just level the ridge. The center of the road will now be five inches higher than the grade, six feet from the center four inches higher than grade, at ten feet two inches higher than grade, at thirty feet twenty inches below grade or twenty-five inches below the top of the road. This is just right for a good earth road, and in first-class shape to make a foundation for a gravel road. Now roll the road-bed with a light roller, not less than four feet in diameter, and keep on rolling it, weighting the roller until the ground will not crowd under a weight of 10,000 pounds. If the earth is damp enough, this will pack the road-bed hard enough.

For a first-class gravel road put on three inches of screened gravel nine feet wide and roll it down hard. Put on two inches more gravel eight feet wide and roll down hard. Watch for ruts or abrasions of the covering, filling them promptly, and you will have a road that will last for twenty years as an earth road, or fifty years as a gravel road. On washed sand like that at Sand Pier and along the shores of Lake Michigan, I would not waste time fixing road-bed, only to bring it to grade and put in culverts and bridges, but put the gravel in just as it comes from the pit, four inches thick in the center and ten feet wide. Roll it down hard and then put on more gravel four

inches thick in the center and two inches at the side and roll it hard. This will make a road that will carry fifty teams a day for twenty-five years at a cost for repairs of one mill per mile per annum for each team or $18.25 a year.

MR. ALBERTSON: In case the center of the road is good, what is the object in plowing it up, and disturbing it?

MR. STEELE: I want to compliment Mr. Bailey, so far as relates to the road bed foundation, the work being thoroughly done, it prepares for a drainage which no other system can equal, and that is the first thing for us to look after; but there is one difficulty in the way, and that is, he is working upon a class of soil that will make a road bed; often we have to contend with a soil, that after all the preparation, is no good whatever. After the preparation outlined in this paper, it is no better than it was before. I refer to light sandy lands. We have thousands of miles of that kind of land in Michigan, and the more you plow and harrow it, the worse it is. For the lighter lands, my experience has been, that the best thing is to prepare a narrow way by smoothing it off, and then putting heavy materials on. We practice it in the Traverse City country, and with good success.

While I am on my feet, I want to give an example of the success we have had in Traverse City, in a way that we didn't expect. The road was built about seven miles, over this light, sandy land, and before the work was done it was almost impossible to get a load through there, the wheels cut so deep into the sand. They made a contract—three townships went in together, to build a stone road about five feet wide, covered with clay and gravel. The stones were obtained in the immediate vicinity of the bay, and brought on scows, and only required a little transportation. These were laid, and most of the road was constructed in the way I have said; but the fall of the year came and they couldn't get the stone on the scows to build the road, so there was a strip of about half a mile, for which it was impossible to get the stone. So they raised the question of what to do. Finally, they decided to fill it in with gravel and clay, and then gravel again. Now, by simply following the road back into the hills, there were great quanti-

ties of nice gravel to be obtained. So they made this portion of the road, connecting the two that had been built of stone, with a foundation of gravel and clay, and gravel above, and to-day, that portion of the road is best It traveled better, and it was less expense to keep it in repair, and it has really stood the heavy traffic of that country—which is immense, much better than the stone foundation. The difficulty with the stone foundation was, that the big hard-heads that they put in, would gradually appear in the surface of the road and form obstacles, and the wheels would cut into the sand.

Now, that is a demonstration of just the point I wanted to enforce; that we have here, in unexpected places, and accessible, materials out of which to make our roads—good gravel, and perhaps a little clay, although I would put in very little indeed, and if you have a certain class of gravel, which packs well, it is well enough without any clay, and gives better drainage. If we will set ourselves to work in that line, we can have all the roads we want. I do not think we need to bother our heads over the question of MacAdam roads, etc. We have the material—only take the system, and have the authority to engineer and construct it according to well-known principles, and we will have the results.

The bottom fact of all this, is drainage. Now, what have we got there on that road that is such a success? Why, we have absolutely perfect drainage, and a perfect road bed all times of year.

MR. APPLETON: When this city, some fourteen years ago, purchased what is now called the New Cemetery; they bought it because it was a loose sand, but it was so loose, that in funeral processions, a hack with four persons in it would be stalled in the sand. It was a problem for the council to know what to do to make the roads. One member was very strenuous in advocating a plank road—it was impossible to make it anything else. I urged very much that they allow me to make an experiment on a part of the hill where the most trouble had been experienced. They finally gave me a $120 to work on about sixty rods, and with that $120 appropriation, I went up there, and of course, it was cut down to the hubs of the wheels. You couldn't go through with a buggy; of course, the drainage

was perfect. I put about three inches of clay which I procured right there, and upon that I put gravel—just as it came out of the bank close by. I put on about four inches, and insisted upon every empty wagon, when it drew the clay, going back over the bed, and there was just clay enough. After that course of gravel, I put another course of clay, and then upon that clay I put another course of smaller gravel, from which I was particular to cull the large stones, and we put that on with a rake. I put that over that hill, and I took four or five laborers, and made some road tampers, and the wagons went over it, and it was raked over again, and it has never broken through, and there has never been a shovel put to it so far as I know. Its excellence convinced the council, and they started me all over the cemetery, and I followed the same plan—it is all sand—only of course, I didn't take so much pains, only on this particular hill.

Now, in connection with road making. What is good on one forty rods of road, isn't on another. The character of the soil regulates what you can do. If there had been clay bottom, in this instance, it would have required sub-drainage. Now, that cemetery road, you might imagine, takes no travel; it doesn't take the travel that Michigan Avenue does here, but it takes a great deal—a vast amount of light travel—hacks, hearses, visitors, and every once in a while, a twenty-ton monument; and I have seen a twenty-ton monument going up there and the horses were not phased; that bears out Mr. Steele's idea,—use the material at hand.

MR. STEELE: How much did you put on the third coat?

MR. APPLETON: I was right there. There is a sort of gravel that is mixed up with loam—there is very little of it. I didn't use that for the lower courses. There was not more than four inches thick of it—that, I kept to go over the last time, wherever there was a little bit of a depression.

MR. VINCENT: How wide did you make you road?

MR. APPLETON: I can't tell you just how wide it was—I made it just wide enough for two teams to pass, and it has stood, I think, about fourteen years.

MR. VINCENT: How much did you crown it?

MR. APPLETON; Not enough to make it unsightly. It

wanted to be a little nicer than a country road—not more than three inches on twenty-four feet.

MR. VINCENT: Did you make the clay foundation crown also?

MR. APPLETON: No, sir, it has perfect natural drainage. The sole purpose in putting the clay on the bottom, was to keep the sand from coming through.

The first course was about four inches clay, then three inches gravel, and then a top dressing of this finer gravel. I had no roller, but I had some broad wheeled wagons, and as the empty wagons went along, I insisted on the broad tire going over different parts; finished off with a garden rake.

MR. VINCENT: I am very glad to hear this question of clay and gravel discussed. I have seen intelligent men, surveyors, who thought they understood these things, who thought certain kinds of gravel would combine, because they had cement, but another wouldn't, because it did not have that magic property. There is some gravel that will combine, just as it comes out of the bank, but it is the clay that makes it combine. If we are to succeed with gravel, we must have a binding material. If it is not there naturally, we must put it in, as the last speaker suggested. The more intimately the clay is mixed with the gravel, the better.

MR. APPLETON: The clay makes a good dry weather road, but there is nothing worse for winter, and of course, if you mix the clay and gravel skillfully, you get a good road for both summer and winter, and then in spring, when everything is thawed and breaking up, this road never goes down, only just a little, an inch or so, but it immediately dries up.

MR. BAILEY: The question has been asked, why did I want to plow up the middle of the road? This is a question that all road commissioners have stumbled over. You can't make a good road without plowing it up, except such sand as is found up along our western coast. The reason is this: You have all dug holes in the ground, and you never filled up a hole with the dirt you took out; the ground is like a sponge, and if you don't dig it up, it will settle, and the finer you get it, the better it will settle. You may put in all the drainage you want to, you have got a sponge there, and you can't get rid of it.

If you thoroughly plow up that road bed, it will settle down so hard, and roll down so hard, that when you drive a wagon over it, loaded with 3,000 pounds, there won't be a rut over ¼ of an inch. Then you are ready to put on the gravel.

I built a road of this kind twenty-two years ago, and there hasn't been but one days work laid out on that course in twenty-two years. I keep the top soil on top—on sand I would use gravel, picking out every stone as big as a hen's egg. Screen the gravel if possible—and I want, if possible, to have six inches of good gravel.

THE PRESIDENT: The committee for investigating this matter of road laws and memorials: On this committee Messrs. F. Hodgman, H. F. Bean, Wm. Appleton, M. H. Bailey, and G. E. Steele, are appointed.

There is one more paper on the subject of roads, from Mr. Hodgman. Perhaps we had better listen to that to-night, and that will finish up the subject, with the exception of a paper on highway bridges, and that will probably go over until to-morrow.

MR. HODGMAN: This paper was written originally for another purpose—not for engineers in particular, and it will touch on a good many points that have already been pretty thoroughly covered, and some that have not; and I was in hopes that if I presented it here, it might spur some one on to bring out something that has not been already said. So I beg your indulgence, if you hear something that has been heard before.

COUNTRY ROADS AND ROAD MAKING.

F. HODGMAN.

We shall not have good roads until farmers realize how expensive bad roads are. Bad roads cost more than good roads. Many are so used to bad roads that they seem to think such roads are good enough. Some would not have good roads for fear that a dude on a bicycle would use them.

Let us figure on what bad roads cost, keeping well within the truth and putting it in round numbers. We cannot be exact. You can't haul more than two-thirds as big a load, nor travel more than two-thirds as fast on a bad road as you can on a good one. The wear and tear is more. The town I live in has seventy-two miles of roads. They are fairly good for country roads. If they were all as good as the best mile, the average load hauled could easily be half larger than it is. What the difference would be in a year depends on the amount of travel. Nobody knows what that is. Assume that, on an average, six teams per day pass over all the roads in town. That includes everything. In that case the difference would be two teams per day over seventy-two miles of road, because then four teams could do the work that six now do. Call twenty-four miles a day's work. Then six days' work of man and team is wasted each day. Call it 2,000 for the year. At three dollars per day that is $6,000 a year wasted, where the travel equals six teams per day, or $1,000 a year where it equals one team per day over seventy-two miles of roads.

Mr. L. goes seven miles to market. He had 1,000 bushels of wheat to sell, and he wanted the money. He would have sold in March at ninety cents but, as the roads were he could not deliver it. He sold later at eighty-five cents. When he did sell, two loads a day was all he could haul. It made twenty-four loads. He could have just as easily delivered it in sixteen loads over good roads. He lost the expense of eight trips. At $1.50 each that makes $12, which the bad roads taxed him that time.

THE SMALLEST ROAD TAX

we pay is that which is levied in the assessor's roll. The bulk of all this tax is unnecessary. We might as well throw the money into the fire. The highway tax that is assessed to us is enough, if it were all paid in money and properly handled, to make fifty per cent better roads than it does make. We never shall have good country roads until they are made and controlled by men who know how. Road making is a trade. We never shall have road work done economically until it is done under the direction of competent, prudent men and paid for in cash. That involves a change in our road laws. Each township in Michigan has for years had the power to make the change, but how many have done it, or will do it. (See section 1354, Howell's Annotated Statutes.) When the country was new and the farmers in the interior of the state had to haul their wheat to Detroit and sold it there at fifty cents a bushel, money was mighty hard to get. Our road laws were then well adapted to the situation. Things have changed since then. Laws which were good under those circumstances are abominations now. We Americans are a hundred years behind the rest of the enlightened world in the quality and economy of our country roads, and there is small disposition among our farmers to catch up with or to head the procession. Accepting things as they are the best thing to do for the improvement of country roads is educate those who make them.

HOW TO MAKE GOOD ROADS.

Get the best location. That text warrants a long sermon. For main roads between important points use the shortest line which is consistent with the easiest grades, and lightest work in building. Locate the line upon the same principles that a railroad is located. We seldom do it. We locate roads on section or farm lines when it would be cheaper to buy a man's farm outright and get a good location, rather than to locate and build it on the boundary line. We are generous. We climb hills and dig them down year after year, at no end of trouble and expense to the public, just to keep some man's fields square so that his corn rows will come out even. We are going to keep right on doing so.

Having located the line, you want to build a road that shall have a smooth even surface; hard enough so that wheels will not cut ruts in it and soft enough for horses' feet to take a firm hold without slipping when hauling loads. If somewhat elastic it will be pleasanter to use. In some respects asphalt pavement is the ideal road.

Clear the road-bed of trees, brush, stumps and stones, if there are any. Cut down hummocks and fill holes. Subsequent treatment will vary as the soil varies. As soon as things are ripe for it, begin grading. Do it systematically. Adopt a permanent grade and work to it, so that work once done will stay done. Finish as you go. Do not begin grading a foot more road than you can finish while you are at it. This does not apply to the big hills and hollows that must be dug down and filled up to all eternity.

Drain clay soils thoroughly. Water *must* be speedily got rid of if you would have a good road. Read that over till you have it by heart. Do not be afaid to go outside the road. Ask the owner to help you open the watercourse across his land till the water has a free outlet from the road. If necessary call on the drain commissioner. A few dollars spent in this way will sometimes do more good than ten times the amount spent on the road itself. Tile drains are a great help to some roads. Lay them lengthwise of the track on each side of it. They do little good under the track because the surface becomes puddled so the water does not reach them readily. Be sure the tiles are laid to a true grade and have a free outlet. Wherever there is a sag in the tile the sediment will settle. If the sag is as great as the bore of the tile it will sooner or later cause an entire stoppage. Lay the tiles from two to four feet deep, according to circumstances. Clay roads must be turnpiked or raised in the center, to carry off the surface water. Plow a back-furrow down the center of the road and keep plowing in until it has the desired slope. Keep the ground finely harrowed so as to have the soil perfectly homogeneous and uniform. Do not raise it too high in the middle. A rise of one in twenty is enough.

In Chicago they used to raise the center of the streets eighteen inches. They now raise them only eight inches and

get better results. When a wagon is on the slope of a turnpike it is tilted to one side. The most of the weight is on the lower wheels, increasing their tendency to cut a rut, which will intercept and hold more or less of the surface water. That softens the ground and the wheels cut deeper. So it goes on from bad to worse until the limit is reached. The steeper the slope the worse it is, defeating the very object it was made for. The strain on the wagon is greatly increased, and by taking the lower wheels and axles at a disadvantage, greatly increases the danger of breakage.

DO NOT USE

a scoop scraper in finishing a road bed. It is a nuisance. It leaves its loads in hard bunches with soft spaces between, some of which will surely develop into mud holes. Flat scrapers with tongues are much better. You can distribute the dirt evenly with them. A road machine is a good tool to finish the surface with, if you know how to use it, or to spoil it, if you don't. When you have the road thoroughly worked, and just where it ought to be, roll it down hard. Farm rollers are not heavy enough to do the best work. Rollers are made on purpose for it, and ought to be used more than they are. Bring the road bed to the grade where it is to stay the first time you plow it, and then be sure that the plow is never put into it again. A man who will plow up a graded and well settled road bed, ought to be prosecuted, and fined to the full extent of the damage he does, including damages done to people's feelings who have to travel over such a road.

If the soil is muck, put an open ditch on each side of the road at least twenty feet from the center, and give it free outlet. If you have good reason to suspect the presence of a sink hole, do not cut the surface at all, as it will do more hurt than good, in case there is one. If the muck is very soft you may have to put in a log crossway for a foundation. Put good solid stringers lengthwise of the road bed. Notch the cross-logs onto the stringers so they will stay firmly in place, and be as even on top as possible. If they are flattened on top, so much the better, they will need but little covering. If not flattened, put on a good layer of brush and marsh hay, and cover it with the best dirt you can get. A log crossway becomes in time a

great nuisance, unless the logs are below frost. The frost lifts them, and keeps the road filled with bumping places.

Except in the softest ground, brush makes a better foundation than round logs, and will last until the ground is settled, so it is no longer needed. Use plenty of it. Pack it as closely as possible, and give it a good covering of gravel with a little clay in it if you can get it.

DO NOT TURNPIKE

a sandy road, nor drain it. Wet sand makes a better road than dry sand. I am not speaking of quick sand. Sandy roads are usually pretty level, and need little, if any grading. They should, where it is necessary, be leveled off as evenly as may be. Encourage grass to occupy all the space it can. It pays well to give some sandy roads a heavy coat of manure for the benefit of the grass. Don't turnpike a sandy road. It is a damage to it. Put a coat of six inches or more of stiff clay on a sandy track, and it makes a pretty good road of it, Straw, marsh hay, waste from sorghum mills, and the like, make good temporary applications for sandy roads. They improve the roads greatly while they last, and it pays well to use them in bad places when you cannot do better.

The time soon comes in the life of a road if it is much used, when it will pay to give it a better surface than can be had from sand, muck or clay. Where gravel can be had it is the first thing to use. It makes a surface hard enough for almost any country road, and is a good foundation for a pavement. When you gravel a road, begin at the part nearest the gravel, and put on an even layer about four inches thick, driving over it as the teams come and go. When one such coat is on, wait awhile until it is solidly packed by the passing travel. Then put on more in the same way, until you have enough on. The object in applying it in this way, is to have all the gravel solidly packed from top to bottom. It makes a big difference whether this is done, or whether you have a hard crust on top with loose gravel beneath. If you have a good road roller, you can pack the gravel with that, without waiting for the teams to pack it. The foundation too, should be rolled as hard as possible. Don't use sand instead of gravel. It is a waste of time and money. The gravel should consist of grains

from the size of a kernel of wheat to a hickory nut. Sharp, angular grains are best. If the gravel is to be put on sand, a little stiff, tenacious clay mixed with it, is an improvement. On clay, it will get all the clay it needs from the road bed.

When your road bed is well graveled, let it alone, except to patch up any holes as soon as they show themselves.

DON'T PLOW IT UP.

Nothing better than gravel will be needed for a majority of country roads. When the traffic will warrant paving, it will generally warrant a railroad, which is pretty sure to come. If the road must be paved, call on an expert for advice. It is the best and cheapest way. I will suggest, that brick is now considered to make by great odds, the best pavement that can be had for the money. House brick will not do. They are too soft. Brick are made on purpose and burned very hard and tough. They are nearly as durable as granite, and can be put down for two dollars or less per square yard.

I will close with a very few words on repairing dirt roads. A road machine is the most effective tool I know of for this use. It wants a man to run it who knows his business. Such men are scarcer than the machines are. The machine should be run over the ground in the spring as soon as the ground is well settled, and afterwards during warm weather as often as the roads become rutted. It will smooth down the rough places, fill the ruts, and leave the road in the best possible shape. If not properly used, the road machine is a nuisance. I believe that a great deal more harm than good has been done with them. Too steep slopes are made with them, and big ridges of loose dirt are left in the center, compelling teams to follow the slopes. No ridge of loose dirt should be left. It should be evenly spread over the surface with the machine, and then rolled down hard.

MR. ROGERS: There is one thing that has not been referred to to-day; that is a good road roller drawn by horses or run by steam. If there are any here who have had experience, would like to hear from them.

MR. HODGMAN: I would say that the O. S. Kelly Co. advertise a good road roller in our annual, and if any members have

use for a road roller, I wish they would consult this company. I believe in patronizing the people who patronize us. We hope in our next Annual to give you the advertisements of other firms who make road rollers.

THE PRESIDENT: There is one more paper incidental to this subject relative to highway bridges by Mr. LaRue.

THE PURCHASE OF METAL BRIDGES.

BY BENJ. F. LA RUE.

Where our path is obstructed by an abrupt depression which we cannot travel through, our alternative is to bridge it that we may travel across. Few highways have been made for the purposes of public travel that have not required the construction of some kind of bridges. In recent years the art of bridge building has developed very rapidly, so that to-day we do not hesitate to attempt to bridge whatever obstacle we cannot remove or otherwise overcome. In these attempts we build bridges and we build bridges—some good, some bad, some quite indifferent.

Just at present the subject of good roads is being urged prominently to our notice by the ever increasing requirements of public travel, and we, as engineers, shall scarcely hold our places in the advance guard of human progress if we do not give to this important subject that attention which it is demanding.

Recognizing the positive demand for good roads, the officers of this Society have wisely given that subject a prominent place at this meeting; and as good roads, comprehensively speaking, are impossible without good bridges, the writer was requested to prepare a paper on the ordinary structures of small span, common to nearly all highways, as an auxiliary to the discussion of the general subject. Though of small dimensions individually, these structures are very important because very common, and they are often very poorly designed—if some of them can be said to have been designed at all. For this reason it was desired that the subject should be treated

quite thoroughly and somewhat in detail, but as such treatment of the subject would require considerable labor and the time was rather short, the writer concluded for the present paper to take up a feature of bridge construction which would be treated rather more superficially. The thorough treatment of small structures will make a good paper for a future meeting.

The subject to be now taken up is of no small importance, and it is very pertinent to the general subject. It is the purchase of iron and steel highway bridges.

Of recent years nearly all bridges of importance or of any considerable span are constructed of metal and are purchased from companies who make a specialty of metal bridge construction. A few observations in regard to this purchase may not be untimely; for among those who are informed concerning these transactions it is an open secret that the sales of metal bridges are often conducted upon what could not be designated sound business principles.

The man who offers to sell you a yard of shoddy for a less price than another tradesman offers you a yard of genuine cloth, does not usually offer you a better bargain. The honest tradesman who charges you a somewhat higher price for the reliable article really gives you a much better bargain, though to the inexperienced eye the shoddy may appear as good as the genuine. If you purchase the cloth you make an honest transaction and the tradesman makes a legitimate profit; but if you buy the shoddy you are deceived and cheated. But if the dealer in shoddy charges you a price that is actually higher than is charged by the honest tradesman for the genuine article, representing to you that his shoddy is very superior material, and you are persuaded to purchase those qualities which by strong flights of imagination and the most sublime lying you are led to believe the shoddy possesses, rather than those sterling but ordinary qualities which by the exercise of common sense you know the genuine article to possess, you are duped and swindled. If a dealer simply "sizes you up," ascertains how much money you have and charges you just that much or a few cents less, for the poorest article which by reason of your inexperience he can persuade you to accept, guaranteeing it to be the very best, you must not look upon that dealer as a swin-

dler—rather thank him for the few cents he leaves you. But if all the dealers in some article in your vicinity, learning that you intend to purchase that article, band together, ascertain how much money you have to pay and how poor an article can be imposed upon you, and mark up the price of that article so that the poorest one which you can be persuaded to accept will just take what money you have to pay, or a little more or less for appearances—well, that *is* robbery, indeed. You have not a very high opinion of tradesmen who gauge their prices according to the amount of money they are able to extort from the buyer, wholly regardless of the actual worth, or lack of worth, of the article sold.

But the writer has been digressing; he has been wandering from his subject and writing about dishonesty and swindling when he should have been writing about bridges. He will resume his subject.

When a metal bridge is to be built, one of the first steps in the ordinary method of proceedure is to advertise for proposals for its construction, as is usually required by law. This is, in intent, a good law; it admits of abuses, but on the whole it probably works to the interest of the public, for the abuses could be greater did the law not exist.

Proposals are usually advertised for several weeks, but as a rule none will arrive until the last day upon which they are to be received. On that day will usually be received a number of proposals, according to the importance of the structure and the prominence of the advertisement; and each proposal will be personally delivered by the agent of a bridge company. Proposals for the construction of highway bridges are almost invariably received in this manner. The thoughtful man will notice this fact and be inclined to look upon it as having some significance. In seeking a reason for it he may ask some pertinent questions:

Why do all these agents come personally to deposit their bids? Why do they not send them by mail and save traveling expenses? "The United States mail," he says, "can surely be relied upon to transport these proposals safely and cheaply," and he cannot understand why bridge companies think it always necessary to send an agent to bid on a highway bridge when

they can bid on large railroad bridges by mail. He is unable to discern any good reason why this should be true, but is inclined to think there is a reason which is not apparent. He does not say this, for the thoughtful man is prudent.

Ah, well; the thoughtful man will draw his own conclusions and will probably profit thereby, while others not so thoughtful will continue to pay dearly for their lack of discernment. The thoughtful man insists that the principles which apply in the purchase of merchandise apply also to the purchase of iron and steel bridges, and that judgment and common sense should be used in the latter as well as in the former. And in this he is certainly correct.

But it may be well to here state that more than ordinary judgment and common sense is required in the purchase of metal bridges. Special experience and ability is necessary if the purchase be a really intelligent one. Any man with ordinary intelligence can distinguish shoddy from genuine cloth and can usually have a reasonably good idea of the worth of either, but only experts, trained and experienced in both the theoretical and practical features of the matter can discriminate with any certainty between an unsafe bridge and a good one, or regarding what may be a reasonable price. He who buys shoddy gets cheated, but that is all. But the official who purchases an unsafe bridge not only allows himself to be cheated out of money that is not his, and thus violates his trust, but he actually endangers the lives of those who have trusted him.

Bridge failures are not every day occurrences, which is a fortunate fact. But such "accidents" do occur, and though not alway accompanied by a loss of life so as to be noticed by newspapers, yet several such calamities have occurred with the most terrible results. Those at Ashtabula, Ohio, where over eighty persons lost their lives, and at Dixon, Illinois, where sixty people were killed, are still remembered. The former was a railway bridge, the latter a highway bridge. Neither of these were "accidents;" they were frightful disasters for each of which was a definite cause, and for which some person or persons were directly or indirectly responsible. The Tay disaster and the recent Moenchenstein failure might be noticed as prominent calamities, but these were in foreign countries,

where bridges are constructed under a system quite different from that practiced in this country.

It is not necessary to seek instances of these calamities in foreign countries, for the failure of bridges, in one way or another, are estimated to occur at the rate of from thirty to forty per year in the United States.

It is to be noticed, that in each case mentioned, each bridge failed under a load which it was supposed to be perfectly able to carry; and this is almost invariably the case where bridge failures occur, for it is seldom indeed, that a bridge has to carry a greater load than it is believed, or even guaranteed to be able to carry safely.

In one case (Ashtabula), the bridge had actually carried as great, and greater loads, many times a day, for years. From this and similar cases, we are forced to conclude, that the fact, that a bridge that carried a certain load once, or several times, is no proof that it will carry the same load again. And this is a fact well established, and well known to those familiar with the properties of iron and steel, though it is not readily accepted by those not familiar with the action of these metals under stress.

From this statement it will be readily understood, that all so called tests of bridges, by placing loads upon them, in the usual manner, are mere farces, gotten up to deceive purchasers. In order to really and intelligently test a bridge, it is necessary to precisely observe the deflection under load, and compare it with the calculated deflection for the same load, and also note whether the bridge recovers its exact former position when the load is removed. Such tests, based upon the elasticity of the metal, if properly performed, will give a reasonably accurate idea of the proficiency of the structure. It is a well known fact, that any load on a metal structure which strains the material beyond its elastic limit, will, if repeatedly placed upon it, finally cause it to fail; and this load is not necessarily but little more than one-half the load necessary to break it down when placed upon it the first time. The most ordinary bridge should be able to carry its usual load without straining the metal to more than one-half its elastic limit, or about one-

fourth its ultimate strength; if this be the case it can occasionally carry nearly twice this load without injury.

There are to-day, hundreds of highway bridges in the United States, which, were they loaded with a closely packed crowd of people, or with a close column of infantry, marching and keeping step, would fall under the load; and such a fall under such circumstances would be most terrible. There are probably highway bridges in the state of Michigan over which it would be unsafe to pass an ordinary traction engine. And these unsafe bridges are, for the most part, not old, decayed wood bridges, but comparatively new metal bridges.

Some of our iron bridges throughout the country are standing, simply because they have never been loaded anywhere near their guaranteed capacity, which is usually eighty to one hundred pounds per square foot of road way, with a factor of safety of four; i. e., straining the metal to one fourth its ultimate strength. It has been aptly remarked that many of these bridges seem to stand from mere "force of habit and pure cussedness."

Except from the result of one thing alone—the corroding depredations of rust, which may be prevented by thorough painting and a little care—a properly constructed iron or steel bridge should be nearly, if not quite as good after a life of fifty years as the day it was erected. This statement does not correspond well with the fact, that all over the country iron bridges but fifteen or twenty years old are being torn down and replaced by new ones. The statement is never-the-less true. These bridges, however, have not all been bad ones, though many of them have been very inferior, for in some cases the requirements of travel have greatly increased.

But this talk about the "fatigue of metal," when applied to bridges, is nonsensical and delusive,—every word of it. So also is the talk about crystalization. No piece of iron or steel on this earth has ever been known to crystalize, except through the influence of very intense heat. Speaking practically, and with reference to bridges after completion, there is no such thing as crystalization, or the fatigue of metal. These terms have been used where bridges have failed, simply to excuse bad work and evade responsibility.

To put upon any bridge, other than a very old one, sadly in need of renewal, any such warning placard as "All persons are prohibited from driving across this bridge faster than a walk," is a disgrace both to the builders of the bridge and the officials who purchased it. It shows a shameless amount of either ignorance or dishonesty—or both, on the part of the builders and a very liberal lack of common sense on the part of the purchasers.

Every bridge on a public highway should be perfectly safe for any team to cross as fast as may be desired, for the heaviest traction engine to cross, for a drove of cattle to cross on a trot, or a column of soldiers to cross on double quick march; and a bridge that is not safe to carry any and every such load, is not safe for public travel.

In this connection the writer wishes to make another statement. It is, that the average price paid for metal bridges is sufficient for the purchase of bridges that would be in every way first-class, and capable of carrying with perfect safety all loads that are liable to come upon them. To this is added the statement, that the bridges actually purchased are, as a rule, not nearly as reliable as they should be, and often not as strong as represented to be.

And here the question arises, how can officials when purchasing bridges, intelligently discriminate, as to be certain that they are getting safe and reliable structures, and the equivalent of the money which they expend? The men on whom this duty falls are not usually bridge experts, and are not expected to be; and this fact is certainly not to their discredit, for it requires years of special study and experience to thoroughly master the study of bridge construction.

But the difficulty has a remedy. The engineer may be called upon to make the design, or to examine and report on such designs as may be submitted, to inspect the material, details and workmanship, and to advise in all matters appertaining to the structure. With an engineer, if he be expert in bridge construction, there is absolutely no guess work about all this; it is with him simply a matter of mathematics and experience.

And there devolves upon us engineers, to give more

attention to this subject which is certainly of great importance, and which is a branch of engineering to which too little attention is paid. We may not all become experts in bridge designing, and this is not necessary; but we can, and should, so inform ourselves, that we can decide with intelligence and discrimination concerning the design which may be submitted to us, and have reasonably good judgment concerning the fairness of the price. It is not difficult to know about what it is worth per pound to construct a metal bridge, and the price of the lumber used, and then to estimate the weight of the metal and the amount of lumber in the structure. This is the way bridge companies get at it, though there are usually other minor items to be considered.

There is no possible way in which public officials can so judiciously and economically purchase a bridge, and know the exact worth of what they buy, as by employing an expert engineer to advise them regarding all matters appertaining to the structure.

The committee on road legislation presented a report which was discussed, amended and adopted and subsequently presented to the state legislature in the following form:

MEMORIAL.

To the Honorable the Legislature of the State of Michigan:

The Michigan Engineering Society, in convention assembled in the city of Lansing the 19th day of January, A. D. 1893, adopted the following recommendations relative to the highway laws of the state of Michigan, and instructed their secretary to transmit the same to your honorable body, which is hereby done, with the respectful request that the points presented be given due consideration and such weight given them as their merits entitle them to, in any changes that may be made in the highway laws of the state. All of which is most respectfully submitted.

F. HODGMAN,
Secretary of the Michigan Engineering Society.

RECOMMENDATIONS.

1st. We favor the adoption of the amendment to the constitution submitted by the state highway commission, but striking out therefrom all reference to state roads, and we earnestly request your honorable body to present to the people of the

state this or such other amendments to the constitution as may be necessary to give the legislature power to enact effective legislation for the improvement of the common roads of the state. We do not believe there is now or likely to be in the future any necessity for state roads. We would also have the amendment state explicitly that the state aid to be given to counties is for highway purposes.

In the event of the failure of this amendment to carry, we would favor,

1st. Classifying all highways outside of incorporated cities and villages as township roads and county roads.

2d. All township roads to be under the supervision of the township highway commissioner under restrictions to be provided by law.

3d. All township highway expenses to be paid from a uniform township highway fund to be provided by act of the legislature by a levy of not less than $1 or more than $3 for each $1,000 of the assessed valuation of the township. Any amount in excess of that to be submitted to a vote of the electors of the township on recommendation of the highway commissioner, stating specifically the object for which the levy is asked, and giving an estimate of the cost of the proposed improvement.

4th. All expenses for county road to be paid from a county fund to be provided by a similar tax levied upon the property of the county and under similar restrictions.

5th. Extend the powers now exercised by township highway commissioners in acting together, so that all such commissioners in the county may act jointly to determine what roads and bridges in the county are of sufficient importance to the people of the whole county, that they should be constructed and maintained at county expense, and establish the same as county roads and bridges. Provide for a suitable representation of the cities and villages in such cases. Place county roads in their charge, their determinations to be carried into effect by a committee to be elected from their own number. They should assign to each township its portion of roads lying on township lines, and by joint action of committees make partitions of roads lying on county lines.

6th. We would make the township the unit of the road district, and make the township commissioner the overseer. Authorize him to let all road work by contract or to do it by days' work in certain cases where he cannot secure suitable proposals for the work. Provide for constant supervision of the roads and for a check upon the actions of the commissioner.

7th. Require from the commissioner annual itemized reports of all work done and money expended by him during the year, to be made in duplicate to the township and county. Provide blanks for the purpose.

8th. Provide for the purchase or condemnation of the right-of-way for highways, and for the acquiring gravel pits, clay banks and stone and for access thereto.

9th. Require that a plat and a correct description of *all* highways be filed or recorded in the office of register of deeds and in the state land office. Require that permanent monuments be planted at every section corner and quarter post in the United States survey within the limits of the road, at every angle in the road, and at every point where the road crosses a section line, and that the distance be shown to the nearest government corners on each side of such crossing if such corners can be found within half a mile. All this to be shown on the plat. Provide that no money shall be expended from the highway fund upon any highway until such plat is filed. Fix fees for recording highway plats.

10th. Make road laws apply to all platted streets lying outside of incorporated cities and villages.

11th. Fix penalty for moving or destroying monuments planted to define road lines, and provide manner of enforcing it.

12th. Provide that all county roads shall have permanent grades adopted and recorded in some county office with profiles of the same. All heights to be referred to one common base or datum for the county. Where the road lies in more than one county, show the difference, if any, in the datums. Show heights of all railroad crossings and streams, with stage of water when the height was taken.

13th. Provide that all work done in constructing graveled and paved roads be in accordance with detailed specifications, all estimates for earth-work, graveling and masonry to be in cubic yards. If work is done under contract, provide for retaining a percentage of the contract price until the entire work is completed, according to contract. Provide means for a strict enforcement of this rule. Provide that no more work be commenced on roads than can be completed at the time or during the season.

14th. Provide for reports to the county of all work done on county and township roads, of the amount of money expended and from whence derived.

Provide for consolidated reports from every county to the secretary of state, showing amount of mill tax raised, amount

of special tax raised, amount of money expended on roads and bridges, both for supervision and construction, and the length of roads located, paved, graveled, repaired or discontinued.

15th. Provide means of securing right-of-way for drains across private property for road purposes and provide for opening and constructing the same.

16th. Add to the pamphlet of highways laws and blank forms such as are now furnished to highway commissioners, instructions as to the best methods of constructing earth and gravel roads, with plans and specifications of small wooden bridges and of culverts.

17th. Authorize the employment of county prisoners, vagrants and tramps upon work for the benefit of the highways.

18th. It is the sense of this society that from our experience the state as a whole furnishes ample material, of good quality, for the construction of good roads, when applied by men who are qualified to superintend such work and by officers who are chosen with this in view. We believe that we should make the most of what we have—both as to materials and officials. All of which is respectfully submitted by order of the Michigan Engineering Society.

It may be added to the above that it is believed, that even though no amendment to the constitution be made, that the condition of our highways may be greatly improved by an incorporation in statutes of such of the foregoing principles as are not repugnant to our present constitution.

F. HODGMAN,
Secretary Michigan Engineering Society.

Climax, Mich.

At the time of going to press, the secretary is glad to be able to announce that the legislature modified the amendment to the constitution that was submitted by the highway commission, by striking out the part relating to state roads, and making the adoption of the county system optional with the several counties.

The amendment was submitted to the people of the state at the spring election, and carried by a large majority. It is a significant fact that it was carried by the city vote, the majority in its favor in the four leading cities being greater than the majority in the entire state. The rural communities, as usual, voted almost solidly against it.

MR. WILLIAMS: I would state before commencing, that I found when I commenced to do village work, that there were very inadequate means for a beginner to find any monuments or surveys that he could tie to, and to meet that difficulty, I devised something of a system which I have followed. Whether it was good or not, I don't know, and the object of this paper is to bring forth ideas from the members upon some better system than the one I propose.

VILLAGE SURVEYS AND THEIR RECORDS.

F. H. WILLIAMS.

It is an axiom in social and business circles, that lawyers and doctors never agree, and it has been more than delicately hinted that surveyors could well be included in the same category. Be the slur just or unjust, it is certain that surveyors often disagree with the surveys of their predecessors, and that numerous law-suits are the results of such disagreements.

It is a well known fact, that if the person who made the original survey had made a complete record of the same these differences would not arise. Surveyors, as a rule, are more careless in their records than in any other department of their work. Articles without number have been written upon the necessity of records, but that necessity still exists, and will undoubtedly continue. Nine-tenths of the law-suits arising from disputed lines and boundaries would never have been brought, if the records of the original surveys had been properly kept. If such a record is made, so that one surveyor can follow his predecessor, or else the errors be so plain that anyone may detect them, the re-tracing of old lines would be comparatively simple, and litigation would be less. The young surveyor very naturally follows the old surveyor, and while he condemns the methods and work of his predecessor, yet he leaves his work with no other monument to his memory than a series of rotten stakes.

In the surveys and grades of villages, this necessity appears as prominently, if not more so, than in any other

department of a surveyor's work. There is, of course, that foundation of all the records, the village plat. I used to regard that village plat with a great amount of veneration and awe, but active contact with it has destroyed all my veneration. While indispensable as that bit of drafting paper is, it is very similar to a city directory twenty years old. Nothing is located where it purports to be. The stake that was at the north-east corner of lot one, block one, has taken a permanent residence at the south-east corner of some other lot. The monuments and stakes, if there were any, are there no more. An indefinite line with no marked length frequently designates the size of important lots. The difficulties which arise from the village plat, are too well known to every surveyor to need any comment. The location of monuments by the memory of the oldest inhabitant, or last year's wagon track, is, to say the least, a very undesirable, if not exasperating, method.

The question which it is the object of this paper to discuss, is some simple, practical manner by which the records of the grades and surveys of a village may be so kept that the surveyor can ascertain the details of the work of the former surveys, and can follow them when right, and avoid the errors when wrong; that the monuments may be so located that anyone can find them, and that the records when made can be used as evidence in any court of law, where there is litigation on these subjects.

In the first place, the charter of every village and the general law should require that each village should appoint a village surveyor, who shall be required under the authority of the common council to establish grades for all streets, and place monuments at the intersection of all streets; shall be required to keep records of all grades and surveys made by him. No other person should be allowed to work in the village without taking out a license, and agreeing that he will furnish the village surveyor with a record and plat of all work done by him. These records and surveys should be recorded by the village surveyor, who should receive a fee from the village for making the record. All such records should be made prima facia evidence of their correctness, in all cases of controversy in the courts. A very convenient method of keeping these records can be made in the following manner:

First, there should be profiles of each street, showing of course, the rise and fall of ground in the center of the street, and also the grade line. Underneath this profile there should be a plan of the street, on which any alteration of the grade for the sidewalk and gutter can be easily minuted. These profiles are intended principally for working plans, and can be easily preserved by pasting in a large scrap book. A book twenty-four by forty-eight inches can be obtained for ten or twelve dollars.

All the grades of the village should be referred to one datum established by the village authorities, and the grades be established by reference to the heights of the grade at the points where changes are made.

Second, for a record of these grades a book can be made containing at the head of each page reference blanks to the proceedings of the common council where the matter was considered, a reference to the surveyor's record book, and also to the profile book. These pages are lined, and marked into columns. The first column shows the stations, the next column shows the height of the grade at each station where the grades angle, and the third column shows the location of the angels in the grade by streets, or other references.

Third, the more complete record however, can be conveniently kept in a third book, known as "The Surveyor's Record Book." This book is headed in much the same manner as the Grade Record. It has reference blanks to the proceedings of the common council, reference to the profile book, and also the grade record. The left hand page of this book is lined, and is specially adapted to the record of grades. There are three columns, one for the number of the station, one for the height of the ground, and one for the height of the grade. There should be written in this book the height of every station, and also, if deemed necessary, the side heights. The balance of this page is left for the location of monuments, which may be given with witnesses, whereby each stake may be replaced if lost.

The right hand page of this book is left for records of surveys made, which adjoin upon the street named on the left

hand page. By means of this book, after the street is once surveyed, and the record of the work made, any surveyor can follow his predecessor, can make estimates of dirt to be moved or the cost of improvements, can find any monument in a short time, and a complete record of the history of each street, and the improvement made upon it can be preserved. If this book is kept up, both of the others could be done away with, although it is much more convenient to use the whole set.

It may be said with some force, that there is a great amount of labor in keeping such records. It is true, but I do not think it is any more labor than it would be to hunt in the streets for monuments which ought to be there and are not, for grades located by sidewalks which have long ago been torn up, or for lines of surveys which have no more record than a rotten stake or bent gas pipe.

In other words, if the work is well done once, and the record of that work carefully preserved, there is much more value given to the village than there could be through a dozen of surveys of which no trace can be found.

MR. GRANVILLE: Do I understand the gentleman to say that he advocated the system that a village should license a civil engineer or surveyor before he was permitted to practice in that village?

MR. WILLIAMS: No, my idea was that any person practicing, should place the results of his work so that anyone might have the benefit of it.

MR. GRANVILLE: Then the idea is that each surveyor who might go into a village to do a little private work, should gratuitously give the result of his labors to anyone who may come in. It seems to me that a surveyor's private notes are his stock in trade, and that it isn't doing him justice to compel him to give them away without any consideration. It is all right where the work done is public work, and public record should be made; but it seems to me where a surveyor does private work, his notes belong to him alone.

THE PRESIDENT: Did I understand Mr. Williams to say that any man who does any work, should follow this plan?

MR. WILLIAMS: No, only to the extent that when his work is

completed, it should be so placed that anyone can find it. I don't think this would apply to a city.

MR. GRANVILLE: It seems to me that it is the duty of city or village authorities to have their streets properly monumented, if it has not been done before they reach that point of development. They ought to do it if it was not done in the original platting; and if it becomes necessary for a private surveyor to go on and make his surveys, and if he establishes permanent monuments, it is done at the cost of the parties for whom he is doing the work. It might be a good thing for the public to know these facts; but some one ought to pay the surveyor if he is going to open up his private notes.

MR. WILLIAMS: If there is anything which the public ought to know, it ought to be where the public can know it.

MR. GRANVILLE: And the public ought to pay for it.

SWING OF THE COMPASS CARD, EMBARRASSMENT OF SHIPMASTERS, AND FINDING THE MAGNETIC POLE.

H. C. PEARSONS.

There is a swing of the mariner's compass card in azimuth, always deviating vessels to the north of their supposed course, particularly on the great lakes and the Gulf of St. Lawrence and other places where the isogonic curves are close together, that is a perpetual menace to the safety of the vessels traversing those waters, and a mystery to our seamen.

This swing, or motion of the card in azimuth, is not generally known, and consequently is never recognized in shaping the course of vessels, though it is readily shown and the resulting consequences explained when we come to know the place of the magnetic pole.

So far, this point has never been definitely located. Capt. Jas. Ross has indeed found a point in lat. about 70° N., long. 96° W., where the magnetized needle stands vertical; and for a time this was supposed to be the magnetic pole. But later observations showed an immense field to the south and east of this point, over which the intensity of terrestrial magnetism is very much greater than at the vertical pole of Capt. Ross.

Some point, of necessity, in this field, must control the direction of the magnetic meridians in the northern hemisphere. When this point becomes known, all the motions of the card due to terrestrial magnetism, may be explained.

Having been diverted twice during the last season (1892) from my objective point, over the same route on Lake Superior, in vessels whose compasses I had just compensated and swung for quadrantal error, so that we knew the position of the card for all headings of ship, I thought it time to know something of the cause of such results.

I first conceived the idea of constructing a Mercator chart, embracing some 20° of latitude and some 40° of longitude, such

chart to cover the region of the lakes and the Gulf of St. Lawrence. Then from different points on this chart to project the variation recorded from observation for those points, and to observe their common point of intersection, which I deemed would be the magnetic pole.

But I soon found my mistake as to the kind of projection wanted.

The variations for the different geographical positions are referred to the geographical meridians, which converge to the pole, while the meridians of Mercator's projection are parallel, affording no such convergences to a common point.

I then made a conic projection, tangent to the 44th parallel, and finally one to the 47th parallel of latitude, so as to embrace in each the territory above specified.

Then I projected the variation as recorded for different geographical positions by means of lines representing magnetic meridians, expecting these meridians or variation lines to meet at some common point in the magnetic field above mentioned. But, to my surprise, no two pairs of these lines that were neighbor to each other, would meet in the same point. Thus, two neighboring lines projected from points to the south-east of this field, would intersect in a point far to the north-west, while the two lines projected from the south-west would intersect far to the north-east of this field—say a thousand miles or more from the first intersection, and so of all the lines projected—any two neighboring lines projected from one side of this field would intersect in a point far on the other side. Yet I observed that they all crossed each other within a small area, a circle embracing, say, 3° of latitude, and their crossings were very evenly distributed over this area, the center of which I deemed to be the "*magnetic pole*," that governed the direction of the magnetic meridian in the northern hemisphere.

This center I found from both projections to be in latitude 67½° N., longitude 86° W.

And here I may remark that these variation lines or magnetic meridians all appeared to be governed, in their intersection by a law analogous to that regulating the plumb line which points, not to the geometrical center of the earth, but

the center of the nearest mass. And we may further suggest that if we assume this magnetic field above referred to, to have a form enlongated in the direction of south-east from the geographic pole, we find the explanation of why the "agonic" line has a "porthand" course, i e., a course that is to the left of the geographic meridian.

Though the graphic method of solving such problems cannot claim to great precision, the fact that both projections give the same results, and the further fact that computations for the motion of the card, based on a knowledge of the relative polar distances, agree almost precisely, as we shall see, with those deduced from observation, for the different geographical positions, show us that for all practical purposes *this determination for the place of the magnetic pole is correct*, though a more elaborate discussion may change it slightly.

Now, comparing the tangents of the two polar distances from any parallel, we have the inverse ratio of the motion of the magnetic needle or the magnetic card to that due to the inclination of the meridians for any difference of longitude. Thus, with this ratio, the inclination or convergency of any two meridians on any parallel of latitude, becomes the measure of the motion of the card between those meridians, subject to limitations to be mentioned.

From consideration of geometry, we know that the inclination of any two meridians on any parallel is found by multiplying the sine of latitude by the difference of longitude intercepted by the two meridians.

To find this ratio, an example will illustrate:

Say it is desired to find this ratio for the polar distance for lat. 43°.

The geographic polar distance $= 90° - 43° = 47°$.

The magnetic polar distance $= 67\frac{1}{2}° - 43° = 24\frac{1}{2}°$.

Thus,

$$\text{Tan. } 47° \div \text{Tan. } 24\frac{1}{4}° = 2{\cdot}35.$$

That is to say,

The motion of the card for any difference of longitude on that latitude, is 2·35 times the inclination of the meridians embracing such difference of longitude. In the same manner, ex-

cept with the use of logarithms, the following ratios are found:

Lat. =	48°	47°	46°	45°	44°	43°	42°	41°	40°
Ratio =	2·54	2·49	2·45	2·41	2·38	2·35	2·33	2·31	2·29

Thus, multiplying any difference of longitude by the factor or ratio for any latitude, and by the sine of such latitude we have the total swing of the card in azimuth, for that latitude and difference of longitude. Or, rejecting unity from the factor, the product will be the change of variation.

A few examples will illustrate:

From Buffalo to Duluth the difference in longitude is 13°, 12′ (See U. S. List of Lights), and the mean latitude is 45°, the sine of which is ·707. Then the total swing of the card is

$$13°{\cdot}2 \times {\cdot}707 \times 2{\cdot}41 = 22°{\cdot}44 \text{ of azimuth,}$$

and the change of variation is

$$13{\cdot}2 \times {\cdot}707 \times 1{\cdot}41 = 13° \cdot 16.$$

From the variation chart of Johnson's Surveying, we have variation by observation

$$\left.\begin{array}{l}\text{at Buffalo} = 4°, 9 \text{ to left} \\ \text{at Duluth} = 8, 7 \text{ to right}\end{array}\right\} 13°, 60.$$

Now as the change of variation is but the excess of the motion of the card over the inclinations of the meridians, if we diminish the total swing by the change of variation, we will have 22° ·44—13° ·16 = 9° ·28 = the inclination of the meridians passing through Buffalo and Duluth.

This 9° ·28 is the part of the motion of the card that is diverting vessels on the lakes to the north of their supposed course. And until within some two or three years, no correction was applied for any part of the swing. Now, however, the change of variation is corrected by taking the "mean" variation of the route over which it is desired to sail, into consideration when shaping course, leaving, as before said, that part of the motion of the card due to the difference of longitude, to divert the vessel to the north. For, if we go down the lakes the card turns to the left, diverting the ship to the north; and if we go up the lakes the card swings to the right, diverting the ship to north as before.

Thus before the "mean" variation was applied in shaping

course, the one-half of this total swing of 22° ·44, or say one whole point was effective in diverting vessels to the north between Buffalo and Duluth.

The departure, or distance due east or west made by a vessel traversing the route between these two ports, is 647 statute miles, as measured on the parallel of 45°, which is about their mean latitude. And the departure, to a one point course for that distance is 126 miles.

Then, because the ship sails on a curve instead of a right line, the northing due to the swing of the card will vary as the square of the distance of eastings or westings made.

Thus if the ship make eastings or westings, say sixty miles, she will make northings one and eight hundredth miles, due entirely to the swing of the card. And if she make another sixty miles of eastings or westings on any course without correcting course for change of variation, she will have made four miles of northings from the same cause.

And this increase of the northings, according to the square of the distance sailed, will continue so long as the ship continues to sail without adjustment of course of change for variation—no matter how many, or what course she may sail on.

This is the bear that has worried our shipmasters on the lakes since vessels have been known there. And this same bear is worrying them now on the northern part of our Atlantic coast, and on the Gulf of St. Lawrence, and has been doing so ever since our history began.

As an illustration of the disasters resulting from a want of a knowledge of this motion of the mariner's card, we may refer to the two hundred wrecks, more or less, on *Sable Island* alone.

This island is some thirty-five miles long east and west, by about three miles in width, with a wide area of sand reefs around it, and located in N. Lat. 44° and between Long. 60° and 61° W.

Being in close proximity to the highway of vessels between Cape Race and our Atlantic ports, it has become a source of terror and dismay to shipmasters—particularly of strangers who have to go into the vicinity of it. So fatal has it been to vessels, that it has become known the world over as "*The Ocean Burying Ground.*"

The consideration of a case will show how this motion of a card, which has hitherto been unknown or unheeded, has contributed to the disasters above mentioned. *Example:*

Suppose a ship—a stranger—from the North Atlantic, when off Cape Race, wishes to shape course for New York or Philadelphia.

Knowing the island to be near his course, the master lays his route some thirty to forty miles to the south of the island, lest he may not have bright weather to afford an opportunity for finding latitude, when wanted—and thinking too, that so much of an offing would cover any possible error in shaping course.

The difference of longitude between Sable Island and Cape Race is 7°—near latitude 45°, and distance say, four hundred miles.

Then calling the sine of latitude .7 we have $7° \times .7 \times 2.4 = 11°.76$ = the total swing of the card between those places. And as it is usual at sea to apply only to the variation at ship in shaping course, then half of this swing will be effective in diverting ship to north of the course she may set out on, for we know that the angle between a tangent and a chord, is measured by half the arc intercepted by the chord.

Then going to the traverse table with the half of this angle, or say 5° 50′ as a course, and with four hundred miles as distance, we find 40.06 miles as a departure. Then multiplying the sine of the course, which is say, S. 60° W., we have 35.21 miles as the northing due to the swinging of the card. So the chances are, that our shipmaster would lay our ship away somewhere on the north side of this dreaded "Bone Yard" of the sea.

This same result may be found in another manner. We have seen that for every sixty miles of departure on Lat. 45°, or near that parallel, the northing due to the swing of the card is 1.08 miles, and that it varies as the square of the distance, and that the difference of Long. is 7°, and from nautical tables we find one degree of Longitude on parallell 45°, is forty-nine miles—that is, our westings are

$$7 \times 49 = 343 \text{ miles, and}$$

$$60^2 : 1.08 :: 343^2 : 35.27 \text{ miles northing,}$$

due to swing of card—almost precisely the same result. And we may remark the close agreement of our computed motion of the card, with that given in "*Bowditch's Navigation.*" (latest revised edition.)

The total swing 10°.76, diminished by the inclination of the meridians, is the change, thus

11°.76— 4°.90= 6°.80=change of variation.

Change per. observation= 5°.88, as per. Bowditch.

Here we should remark, that we are too far east for the law of the ratios 2.4 to prevail, as we shall presently explain—though as our course lies almost precisely across the isogonic curves, our results by computation may be regarded as quite correct.

And it must be observed too, that the isogonic curves are supposed to cross the parallels at right angles, and this, for all practical purposes may be regarded as so on the lakes, but the case is very different along the northern part of our Atlantic coast, and on the Gulf of St. Lawrence, where they cross the parallel at an angle of about 52°, so that a given amount of longitude does not cross as many of them, as if they crossed the parallels at right angles.

Then multiplying the expression used for the lakes, by the secant of this angle, we will have the change of variation that would be traversed by a given amount of longitude at right angles to them. An example will illustrate.

Say it is desired to compute the change of variation between 75° and 65° of W. Long., for mean Lat. 43° N.—embracing the coast from Delaware to Halifax.

Arranging for logarithmic computation, we have,

Diff. Longitude =	10.	Log.	= 1.0000
Mean Lat. 43° : Sin. =	.682	"	= 1.8338
Ratio Less 1 = 2.35 — 1	1.35	"	= .1303
Secant 52° =	1.624	"	= .2106
Change of variation =	14.°96	"	= 1.1747

From table 50—Bowditch, we find for

Lat. 45° N. Long. 65° W.	Var.	= 21°. W.
" 40° N. " 75° W.	"	= 6°. W.
Change for variation pr. observation		= 15°

This close agreement of the computed with the observed value of the change of variation, for change of geographical position does not prevail to a great extent from the plane of meridian 86° W., but it speaks, not only for the excellence of the work of observing for variation, but for the correctness of our determination for the place of the "*Magnetic Pole.*"

By going east or west from the plane of this meridian, to a meridian that is at right angles to this plane, or nearly so, we come to a point from which the distance to each of the two poles is the same—or nearly so, for some distance.

At this point, all the ratios that we gave in a table, become unity, and pass to the reciprocal form—attaining their minimum value at the opposite longitude—same latitude. Thus, the ratio of 2.4 for latitude 45, becomes unity at a quadrant distance from us east or west, and $\frac{12}{12} = \frac{5}{12}$ in the opposite longitude.

The place at which they become unity, is indicated on the variation chart by the isogonic curves, becoming tangent to the parallels of latitude, or nearly so—so that change of longitude produces little or no change of variation.

These areas of little or no change of variation, for change of longitude are seen at between 30° to 50° W., and between 110° to 150° W. longitude—Latitude 30 N. to northward, where only changes of latitude gives much change of variation.

At our opposite in longitude, the distance to the magnetic pole being greater than with us, the change of variation will result from a deficit of motion of the card, and a vessel would be diverted to the south, instead of the north, as with us.

Having learned how to compute the swinging of the card in advance, for change in geographical position—particularly on the lakes, our Atlantic coast and the Gulf of St. Lawrence—where of all places on the face of the earth shipmasters are in want of help—we are prepared to show, at least, a "*little light.*"

It will be observed that the factors we have used in our computation for the swinging of the card between say, latitude 40° and 50°, vary so little, that for all practical purposes, we may take the mean of each of them for the factor for the whole belt of latitude.

Thus, we may take for the mean ratio,	2.38
which diminished by unity for change of variation, is	1.38
For sine of the mean latitude, take	.69
For secant of obliquity of isogonic curves, 52°	1.62
For the divisor 2. take	.5

Then collecting these factors into one, and representing the difference of longitude to be traversed in the contemplated run of ship, by D, we have

$$1.38 \times .69 \times 1.62 \times .5\ D = .78\ D = \textit{Correction.}$$

RULE.

That is to say, .78, or for convenience of computation, say 80% of the difference of longitude to be traversed, is a *correction* to be applied to the right, in making eastings, or to the left in making westings, to counteract the swinging of the card.

Applying this rule for the correction of our run from Cape Race to Sable Island—difference of longitude 7°—ship making westings, our correction should be to *left* $.8 \times 7° = 5°.60$

Our correction by full calculation was = 5°.88

On the lakes where the practice of taking the mean variation over the run to be made is in use in shaping course, I have recommended to

Take half the longitude to be traversed as a "*correction*" to be applied, as in the above rule.

I have had the pleasure of seeing the vessels that run me off my course in the early summer, make a first-class course over the longest single run on Lake Superior,—having instructed the masters in the above rule.

Ferrysburg, Mich., Jan. 13, 1893.

Drainage Survey: "Waiting for the Line to be Cleared."

A CASE OF DRAINING THROUGH QUICKSAND.

F. F. ROGERS.

The Crapo farm is intersected by the C. & G. T. railway at a point about twelve miles west of Flint, in T. 6, N. R. 5 E. It was formerly bought by ex-Governor Crapo, is now owned by W. W. Crapo and managed by S. T. Crapo, grandson of the ex-governor.

The farm consists of something over 1,000 acres of land, a large part of which originally was a bad marsh depending on Swartz creek for an outlet. The main drainage is secured by a large open ditch extending from Swartz creek westerly through the center of the farm. This ditch, when my attention was first called to it in the summer of 1890, was not deep enough to give satisfactory drainage to the upper parts of the marsh. I ran a careful line of levels along the ditch, taking reading in the bottom of the ditch and on the bank, finding very little fall—about one foot to the mile. I established a grade line from the bed of Swartz creek with a fall of .04 of a foot to 100 feet. This caused a cleaning out and deepening of the old ditch from six inches to one and one-half feet. This was done, but in so doing a stratum of quicksand was encountered, about one foot above the grade line, near the center of the farm, and where the ditch was from four to six feet deep. However, the work was carried on to completion, and the next year I was asked to examine the ditch again and see how much the bottom varied from the established grade. I found it all right except through this quicksand where it had filled, as a matter of course, one foot or more. Then we decided to put in an eight-inch sewer pipe with well cemented joints through this quicksand and on the established grade, the ends opening in silt basins made of plank.

This sewer pipe was laid one side of the center, leaving the open drain obstructed as little as possible. All of the tile on this part of the ditch were admitted to the sewer with the proper connections.

This has been in successful operation over a year; has not varied at all from the grade line as established, carries all of the flow in dry weather, while the open ditch serves for an overflow in times of high water. Thus the lands above the quicksand were provided with as good drainage at though the quicksand had not existed.

THE PRESIDENT: This paper reminds me of an incident in my early experience, and shows how easy it is sometimes to accomplish what seems to be a very difficult operation. It was the first sewer which I had ever constructed, and I had very little experience in anything but railroad engineering.

I employed two courses of brick and a wooden skew back. These skew backs were eight feet long. The contractor came one day and said he would have to throw up the job; he had gotten into a bed of quicksand and had tried every possible expedient to get through, but with no success. As fast as he would put the brick in they would disappear. I went down to see what the trouble was. I never had had anything to do with any such thing before, but I knew that it wouldn't answer to let him or anyone else know that I didn't know what to do. It happened he had been using some slabs from the saw mill, eight or ten feet long, for holding up the sides of his ditch, and as a last resort, I told him to lay these slabs crosswise, across the ditch, and then go on. He did so, and although that was twenty-one years ago it has not given the slightest trouble since. All that was necessary was to keep the brick out of the quicksand until the mortar had time to set.

MR. SKEELS: I was employed this last summer, in laying the track for the Lansing Driving Club, near this place, on the west side of the grounds. We had to do a good deal of grading, and just as the work was nearly completed, we struck a bed of quicksand—places as large as the table where it was all of a teeter; and they thought they would have to raise the grade of the whole track in order to get rid of it. I suggested to them to lay a tiled drain from that quicksand to a point where they had tiled drain already. This was Saturday. They commenced then, and put tile drain in, and had it in operation early Sunday morning. Monday noon we made an examination of the ground, and it was solid enough so that we went on with the construction of the track.

PUBLIC WATER SUPPLY AND PUBLIC HEALTH.

W. R. COATS, C. AND S. E.

Mr. President and Gentlemen of the Convention:

There is perhaps no question before the American people today, and it involves all the peoples of the entire human race, of such transcendent interest and importance as is the question of *Public Water Supply.*

The well-being, comfort, health and life of the human race, is more closely identified with, and involved in, the *quality* of the water used in our domestic economy, than in any other—perhaps all other causes combined.

I speak here in a general sense relative to *public* water supply; as only in this sense has the engineer very much to do with the subject, *practically*; yet I wish to treat the subject fully and comprehensively, in both its *public* and *private* bearings.

I wish it understood also, that the question of *Public Drainage* is included as a part of my subject.

Public drainage is made more necessary, indeed almost *compulsory*, by the introduction of a public water supply, but public drainage is not posssible without the aid of public water supply, so that the two questions naturally and properly go together, and should be treated under one head.

I believe that more *ill health*, *sickness* and *death* results from bad water supply and bad drainage, than from all other causes combined.

Disease germs abound in a thousand fold greater proportion in the water we drink, than in the air we breathe, and are far more dangerous taken into the system with the water, than with the air. I very much doubt whether disease germs are *primarily* produced in the atmosphere at all, but these germs are doubtless taken up by the atmosphere from the water, and thus conveyed into the human system in the air we breathe.

In low, marshy districts, where the waters are always loaded with decaying vegetable and animal matter, with all conditions in the highest degree favorable to the production of "*bacterium*," the most minute microscopic disease germs known, the atmosphere is very much of the time dense with fog and moisture. In absorbing this moisture from the *stagnant*, *steeping* waters, doubtless, vast numbers of these minute disease germs are taken up; so that in such localities, both elements, the air and the water unite in their attack upon the health and lives of all who live in such places; hence, the world over, such places are the most unhealthy.

In the temperate zones, where frost arrests fermentation and decay for several months each year, the diseases produced by this agency assume comparatively mild forms; but in the tropics, and especially among the dense population of Hindostan, where this ferment, putefaction, decay and germ developing process is *forever* at work, the result is frightful. Here all the terrible plagues that have afflicted the human race since the dawn of creation, are fomented, and start out on their tours of world-wide devastation. The terrible destructiveness of these periodic plague epidemics is vastly enhanced by the *fears* and *ignorance* of mankind. When a plague starts out on its tour of devastation from its *Asiatic birthplace*, all the people in its pathway become panic stricken with fear, indeed thousands dying from fear alone. It is at once accepted as true, by the mass, that the moment a case of *plague* or *cholera* appears in a place, the entire atmosphere is tainted, and everyone in danger.

I believe the truth to be, that a case of plague or cholera cannot be communicated through the atmosphere, except possibly in wet, filthy localities where the atmosphere is always dense with moisture, and even then perhaps, only when the disease is largely prevalent there.

I think that cool, calm, critical investigation will show that *personal contact* is necessary; that the germs of the disease must be taken into the system before the disease itself can be produced.

Strangely enough, the last place from which this enemy is looked for, is in the direction of its almost invariable

approach, namely, through the medium of our drinking waters.

Water is the *natural developing place*, and *home* of all these disease germs; and water is among the first and most necessary elements of human existence, and yet the average human being is more careless concerning the *quality* of the water he uses than about anything else in his daily life. That which most vitally concerns his well being he, through his ignorance, gives slightest attention to. If we can so educate the people that these things can be *seen* and *understood* in their *true* meaning, then, and not till then, will the question of public water supply receive the attention and treatment its great public importance calls for.

The term *public* water supply is generally understood as applying only to cities, villages, and other large communal aggregations, where a general system is designed to provide for the wants of the entire community; but if we confine ourselves to this view, we leave entirely out of the consideration by far the greater part of all the people.

Except in a very few of our larger cities, by far the greater portion of even our *urban* population obtain their water supplies from *private* sources, almost invariably the ordinary private well, this source being almost *universal* among all *rural* populations. The waters of the ordinary private wells are the most *impure* and *dangerous* waters that we can use; all the more dangerous because of the almost universal *belief* in their purity and excellence.

In this city (*Lansing*), in *Jackson*, in *Kalamazoo*, and indeed in every city in the state except Detroit, more people patronize the *deadly private wells* than patronize the public supply, regardless of the character of the water. Jackson, with 25,000 people, and a public water supply system inaugurated twenty-three years ago, to-day only supplies about 8,000 of her people with water from the public source, leaving 17,000 still wedded to the *poisoned* water of their private wells.

Kalamazoo, with about the same population, and with one of the finest and most excellent water supplies in the world, yet only supplies *two-fifths* of her people from the public source, all the rest taking their supply from the *poisoned* wells.

The chief reason why the people are so slow to discard their

private wells and adopt the public supply, arises from the fact that the almost universal belief seems to be that the ordinary private well furnishes the *purest* and *best* water to be obtained from any source. Another weighty reason may be found in the fact that most of our public water supply developments are so *crude* and *imperfect*, and our water works plants so *inefficient* and *unsatisfactory* in service that the people very largely prefer to keep in the *old channels*.

In proof of the correctness of this view, we may refer to the two cities of Kalamazoo and Ypsilanti. Kalamazoo, with a *perfect* water supply, so far as *quality* goes, and a water works system inaugurated twenty-four years ago, has to-day only 1,800 service connections with her Public water mains, representing only *9,000* of her *22,000* people. Ypsilanti with a water supply of similar quality, and a water works plant inaugurated only *three* years ago, has to-day over *900* service connections, representing *4,500* of her *6,000* people as using the public water. This shows that the *quality* of the public water supply *service* is more important in the public estimation than is the *quality* of the public *water supply*, and that it is well nigh impossible to bring the people into full and general patronage of a public service of such *low grade* as furnished by water works systems of the *Kalamazoo* and *Jackson type;* and four-fifths of all the water works systems of the country are of this inferior type. The only way to change this order of things and place this all important question of public water supply upon a proper footing, will be to educate the public up to a proper knowledge of what a proper public water supply *is* and *means*. Not only must the public be educated up to a true knowledge relative to the *quality* of the waters used and the vital interests involved, but *practical* workers in this field—often only *pretenders*—must be educated up to a higher conception of the "MECHANICS and ENGINEERING" involved.

One of the greatest obstacles we will encounter in this educational crusade, will be the popular faith in the purity of our private well water supplies. To overturn this popular faith will prove an herculean task, all the more so from this wonderful fact: This faith *is primarily well founded.* It is only through the fault of the *mechanics* and *engineering* involved that all the

mischief and danger arises. The *prime* source of the water supply of our private wells *will* furnish the *purest* and *best* water obtainable from *any source*. It is only in the *mode* of development *and utilization* that we are all wrong. *Nature's* process of filteration in the strata of "*Mother Earth*" is far superior to anything that man has yet discovered, or probably ever will discover. In taking our water supply from the *ground*, we must take it from comparatively near the surface, as if we go very deep, we usually find the water so highly impregnated with mineral matter as to be unfit for domestic use. On the other hand, we must *never* take it from *above* the *danger line* of *surface contamination*.

In all cases where the rainfall penetrates the earth and percolates through its strata, these waters in their downward passage become contaminated by largely absorbing the impurities of the atmosphere, and of the vegetable and animal matter encountered, so that we will almost invariably find the *upper levels* of the first subterranean water stratum more or less contaminated with *organic* matter. But right here comes in NATURE'S grand saving clause. It is found that in these *fixed* and *permanent subterranean* water strata, the water never becomes contaminated but to very *slight depth* by organic matter, all this matter being held in suspension *at* or *near* the surface of the water stratum, very much as oil and other lighter matter is held at the surface; so that to obtain *good* water all that is necessary is to go below this thin stratum of *bad* water, and yet not so deep as to encounter the mineral impurities below. In this way every private or public well in the land may be made perfectly safe, if located in a water bearing stratum of adequate thickness or depth.

As now constructed, nearly all these wells only slightly penetrate the water stratum, simply *skimming* their supply from the extreme *surface* of these waters, thus, of course, getting the *cream* of all these *contaminations*. The fact that the organic gases which poison the waters of our private wells, do not affect the *taste*, *looks*. or *smell* of the water, unless present in gross form, renders it all the more difficult to convince the average observer that such water is *dangerous*.

It is the prevalent belief of most people that the water of

their own wells is exceptionally good. As they draw up the "*old oaken bucket*" and drink of its sparkling waters, it is natural to revert, with grateful feelings, to the beautiful sentiment that inspired the production of that old poem. But place a sample of this same sparkling water under the glass of a powerful microscope and what you will see there will speedily banish all romance and sentiment.

Our cess pools and privy vaults and defective drains, are the most dangerous sources of contamination for the water of our private wells. The disease germs in such places are the most dangerous that can be taken into the human system; and if the drainage of these places reaches our drinking water wells, even if in ever so slight a degree, these germs surely will be taken into the system.

The popular belief that twenty-five, fifty or one hundred feet of intervening earth between our cess pools and our wells furnishes ample protection, is entirely fallacious. A little, plain, homely, practical truth will go much further in dispelling this illusion than will whole volumes of theory and metaphor.

This was very clearly illustrated in the experience of the city of YPSILANTI in developing her public water supply and drainage systems. While planning and constructing these works, I tried in every way to impress upon the minds of the people the danger lurking in the waters of their private wells, and the necessity for connecting with the public supply. Very few could be made to believe that the water of their wells was bad, the prevalent belief being that it was exceptionally good. Least of all could they be made to believe that there could be any danger of contamination from their cess pools and privy vaults.

In constructing a trunk line sewer through the finest residence portion of the city, it was found necessary to go several feet deeper than the neighboring private wells with this sewer trench. Within a very few days every well within two blocks (*750* feet) was *drained dry*. After this, it was not difficult for these people to *see* and *believe* that where the water of their wells could so quickly find its way to this sewer trench, through 750 feet of intervening earth, certainly the fluid contents of their cess pools, seldom fifty feet away, could very easily reach their

wells. Had these same private wells been ten feet deeper, and so constructed that water could enter them only through the *bottom*, all danger would have been averted.

I will dismiss the subject of private wells with this observation: If the instructions outlined above are followed, every private well may be made perfectly safe.

To go back to the main subject, *public water supply*, while we find nothing involved very different in principle, yet we find the question far more difficult of treatment. In a private supply, we usually have only the limited requirements of individual cases to provide for; in a public supply, we have the collective whole on our hands.

In almost all localities, we can easily find water enough in the ground to supply a private family of five or ten persons, but when we come to a public supply, involving the needs of five thousand, or five hundred thousand people, it seems a very different thing, and yet it is different only in relative proportion, and it is very rarely that we find the obstacles to success insurmountable.

I have a religious faith, that wherever the ALMIGHTY has ordained that human beings shall find an abiding place, HE has provided within easy reach, every requisite for their comfort, and chief among these requisites, is *good water*.

But very often we *disobey* all God's *sanitary* laws, and thus bring endless suffering and misery, where *obedience* would have brought peace, comfort and happiness.

Many of our cities are to-day poisoning their people, through the agency of corrupt public water supplies, developed in partical or total disregard of all natural *law* and *principle*; many other cities with water supplies ample in *quantity*, and excellent in *quality*, often wantonly poison these excellent water supplies with notoriously bad water, upon every little fancied emergency, and thus keep the health and lives of their people in constant danger.

The city of *Jackson*, with a most excellent public water supply of three million gallons of water per day, while her consumption is only half this amount, yet turns the waters of a foul disease, germ-laden stream into the water mains and service pipes of her public water system, perhaps fifty or one

hundred times a year, or as often as they happen to have a fire.

The only necessity for this terrible and inexcusable practice is entirely due to the *low grade* of *mechanics* and *engineering*, as exhibited in the *development* and *management* of the Jackson water works system.

It is doubtless true that the great majority of our officials on "Boards of Public Works," are honest, and aim to perform their duties faithfully. The chief trouble arises from the people themselves, electing *incompetent* men to serve them in these important places.

A man may be a good shoemaker, a good blacksmith, doctor, lawyer or minister, but the chances are that not one of all these would be in the slightest degree acquainted with the *mechanics* and *engineering* involved in a public water works development. Often some of the least competent of these people are placed in positions of authority upon such boards, and *assuming* to *know*, will perhaps work more mischief in one administration, than a dozen succeeding administrations can undo and rectify. The poor, patient, deluded tax-payers, however, uncomplainingly foot all the bills.

Doubtless, the most striking instance of inefficiency, gross mismanagement, and reckless waste of almost *matchless natural advantages*, is afforded by my own home city, KALAMAZOO, in the management of her public water works system. I should prefer not to use this case in illustration, could the same end be accomplished, and the same good be done otherwise, because everything connected with the Kalamazoo situation is in some degree *personal* to myself; but it is only the *public* good that I desire to promote, and this means the *Kalamazoo public good*, as well as the general public good.

In a case like this, the plain, unvarnished *truth* constitutes what may be termed *heroic* treatment, and such treatment is the only possible way to reach such cases, and accomplish any good.

Kalamazoo has one of the finest public water supplies in the known world, and yet this splendid water supply is so managed, as to be, oftentimes, well nigh worthless.

Twenty-two years ago I developed this water supply, for the then village of Kalamazoo.

This supply is taken from the ground by means of a large well, twenty feet in diameter, and thirty feet in depth, this being the *first* large public water supply ever developed in this manner. Neither the *engineering profession*, or the *public*, had any faith in the feasibility of this enterprise at the time, and it was only after I *guaranteed* the *engineering success*, and *advanced half* of the estimated *cost* from *my own pocket*, that the village authorities permitted me to go forward with the enterprise. The result of this *pioneer* experiment far exceeded my most sanguine expectations. When the work was completed, we had a well that would furnish *three* and *one half million gallons* of *water per day*, and this water was so beautifully *clear* and *transparent* that a nickel could be *plainly seen* on the *bottom* of the well, through a depth of *twenty-seven feet of water*. This marvelous well will to-day, after *twenty-two years constant use*, still furnish three and a half million gallons per day, of the same fine quality of water, and yet the *management* of this splendid water supply is so *bungled* that the city is kept almost constantly on the *danger line of water famine*, and her people in an almost *constant panic* of *fear*. What a comment upon municipal *mismanagement*, in a city with a water supply of *one hundred and seventy-five gallons per capita per day* for her *entire population*, and while supplying only two-fifths, her people is in almost constant fear of a *water famine*, and to meet emergencies, makes provisions to admit the water of a *sewage polluted stream* into her water mains, thereby *poisoning the entire water supply*, and *endangering* the *lives of all her people*.

London, *Liverpool*, and other large European *cities* find that *twenty-seven* to *thirty-five* gallons per capita per day is an ample supply of water for *all purposes*, and this where the *entire population* are consumers. Yet *little Kalamazoo*, with a supply of 175 gallons per capita per day for *all her people*, cannot manage to properly take care of *half of them*. Comment is unnecessary. The whole secret of this miserable situation is simply this: Kalamazoo and all similar water works systems, in their arrangement, simply live from *hand to mouth*, with no possible provision for *emergencies*. While she has at command at *all times* three and one-half millions gallons of water per day, she

cannot at *any time exceed* this rate for a *single half hour.* Yet she has placed herself in a position where she is liable to be called upon for water at *any moment*, at the rate of *seven* or *eight* million gallons per day. As an engineer, I maintain that it is *criminal* to assume such *liabilities* and *obligations* without making *adequate* provision to *meet them.*

To make such provision at Kalamazoo is exceedingly easy; and while such improvement would make everything safe and in the highest degree efficient, in *every branch* of the *public* and *private* service, it would at the same time greatly *reduce* the *cost* to the *tax payer.* At Kalamazoo, with a water supply of three and one-half millions per day, and a pumping capacity of six millions, it is not possible to exceed the three and a half million rate for even a single half hour for any or *all* service. With a small storage reserve, such as the *natural* advantages at Kalamazoo will afford at the *minimum* of cost, water at the rate of *ten* or *twelve million gallons per day* would be *always* at command for any *emergency*, and for as long a time as such emergency is ever likely to last, and this without any *increase in the present supply.* And the *quality* of the water will not be at all *impaired* by this *storage reserve.*

Under such an arrangement *every branch* of the service will be *incomparably superior* to what it is *possible* to make it *now*, and all danger of *water famine* will *forever disappear.*

The city of Ypsilanti, in her public water supply development, furnishes a perfect illustration of the truth of all this, and every feature there has been fully and completely *demonstrated* in *practical use.* Ypsilanti has an excellent public water supply of two million gallons of water per day. She has only one-fourth the population; yet in three years time she has *one hundred per cent more* water takers in proportion to population than has *Kalamazoo* in twenty-four years; and her consumption of water is in excess in the same proportion.

Ypsilanti has a maximum pumping capacity of only two million gallons per day, yet at *any time* and at *all times*, whether her pumps are *running* or *idle*, she has always at *command*, water at the rate of *eight* or *ten million* gallons per day for *any* and *every emergency*, for so long a time as such emergency is ever likely to last.

Every gallon of this water is always under *one hundred pounds pressure* to the square inch, at pump datum, and is thus available at *all times* for the highest and best effect in *every branch* of the *public* and *private* service. These works have reached a self sustaining basis in three years from date of construction. In the Kalamazoo and Jackson systems, the water pressure in the mains never exceeds an average of *thirty pounds* unless specially called for and worked up *after* the *alarm* is sounded. This low pressure is never efficient or satisfactory in *any branch* of the service. In these works, if the pumps stop an instant at any time, or from any cause, the entire service, in every branch, is *instantly dead* until they start again.

In the Ypsilanti type of works, the pumps may *stop entirely* for *six* or *eight* hours in every twenty-four, and yet every branch of the service will go on precisely as if the pumps were running. Indeed, this is precisely what does happen every day at Ypsilanti. At night the pumps are always shut down, and the pumping power is transferred to the electric dynamos, and thus utilized to run the electric street lighting plant. The Ypsilanti type of public water supply as far surpasses the Kalamazoo and Jackson types in *economy* as in efficiency. The Ypsilanti works reach a self sustaining basis in *three years*; Kalamazoo and Jackson, with not better than a *fifth rate* service, are still, at the end of *twenty-three years, thirty thousand dollars behind each year.*

These cases ought to convincingly show how very important and *necessary* it is to adopt *correct principles* in the planning, construction and management of our public works, and more especially as relates to public water supply improvements.

Ypsilanti, at the end of three years, is directly supplying *seventy-five* per cent of her *entire population* with water from her public works, and everyone is entirely satisfied with the service in every branch.

Kalamazoo and Jackson, after *twenty-three years*, are only supplying about *thirty-five per cent* of their population from the public source, and very few of these are satisfied with the service in any branch.

These cases ought to conclusively show the great impor-

tance and necessity of good engineering and good management in this grand field of public work, and that satisfactory results are not otherwise possible.

I have freely used the above named cases in illustration because I am perfectly acquainted with every detail in each of these cases, and because I believe the *public interest demands* this information, and that it is the clear *duty* of the *engineer possessing it* to furnish it.

In the main, all the defective points cited in the Kalamazoo and Jackson cases, will apply to all works of that type, and I feel that it is the duty of the *true engineer* to do his utmost in eradicating these defects.

As before remarked, we cannot do full justice to the question of public water supply, without including the question of public drainage; but I am occupying so much time with water supply that I do not feel justified in devoting much time to the discussion of public drainage, at this time, and will only indulge in a few general remarks on this subject.

I believe it to be of the highest importance, and among our first *duties*, to provide efficient house drainage *everywhere*—in city, in village, and in the country.

Surface or storm drainage, and house drainage, should always be kept separate and distinct. A house drain and a storm drain combined, is a monstrous blunder, and brings endless danger.

The true object, and office of a house drain, should simply consist in the *quick* conveyance of all the filth produced in and about the house safely beyond the *danger limits*.

All house filth is comparatively harmless in its fresh state, and if disposed of before fermentation and putrefacation takes place, nearly all danger is averted; but if we allow this filth to accumulate in cess pools, privy vaults, and other places about our dwellings, we simply leave the door wide open, and *invite* every danger and disease.

If we permit this filth to accumulate, and be stored about our premises, and to be in constant process of fermentation and decay, we are establishing precisely that condition which will most effectually poison the air we breathe, and the water we drink; and at the same time *preserve*, *reproduce* and *perpet-*

uate, the disease germs given off by every case of *sickness* and *death* ever occuring on these premises.

Had this filth been properly disposed of as fast as made, then no *later occupants* of these premises would ever be endangered beyond their *own individual responsibility*.

Both public water supply and public drainage are vital public necessities, but we cannot establish and maintain public drainage without the aid of public water supply. This fact greatly enhances the *primary* importance of public water supply.

I believe this to be true in our situation to-day, that all that is necessary to secure the highest effectiveness and most widely beneficial results in both these grand fields of public work throughout our entire land, is to educate the public up to a true knowledge and understanding of this grand field of work and its requirements.

THE PRESIDENT: This paper discusses a subject which is fast becoming one of the utmost importance in this country, and contains much that is worthy of the serious consideration of the members of this Society. Mr. Coats' theory that the boundary line between good and bad underground water is a very narrow one is not generally understood nor accepted. It is a very important one if correct, and it is to be hoped that at our next meeting Mr. Coats will give us the facts upon which he bases it. The language of this paper may appear to be occasionally severe, but Mr. Coats distinctly disavows any intention of reflecting upon any member of this Society or of the engineering profession. His criticisms are directed solely at the imperfections of the system of water supply which depends solely upon direct pressure without storage.

WATER WORKS AT SOUTH HAVEN, MICH.

GEO. S. PIERSON, ENGINEER.

The city of South Haven lies on the shore of Lake Michigan at the mouth of the Black river. It is a place of about 2,500 inhabitants. The larger portion of the city, including most of the business blocks, lies on a plateau south of the river and close by the lake. About one-third of the city occupies a similar plateau north of the river. The portion of these plateaus occupied by buildings lies at an elevation of thirty or forty feet above the level of the lake.

South Haven has within a few years suffered two disastrous fires, and about a year ago voted bonds to the amount of $35,000 for a system of water works. This amount was subsequently increased to $40,000, a portion of which was expended in the equipment of a fire department and the extension of lines of water pipe not originally contemplated.

The water supply is derived from tubular wells on the lake front and is forced into a stand pipe located near the business portion of the city, and standing on ground about thirty-five feet above the level of the lake.

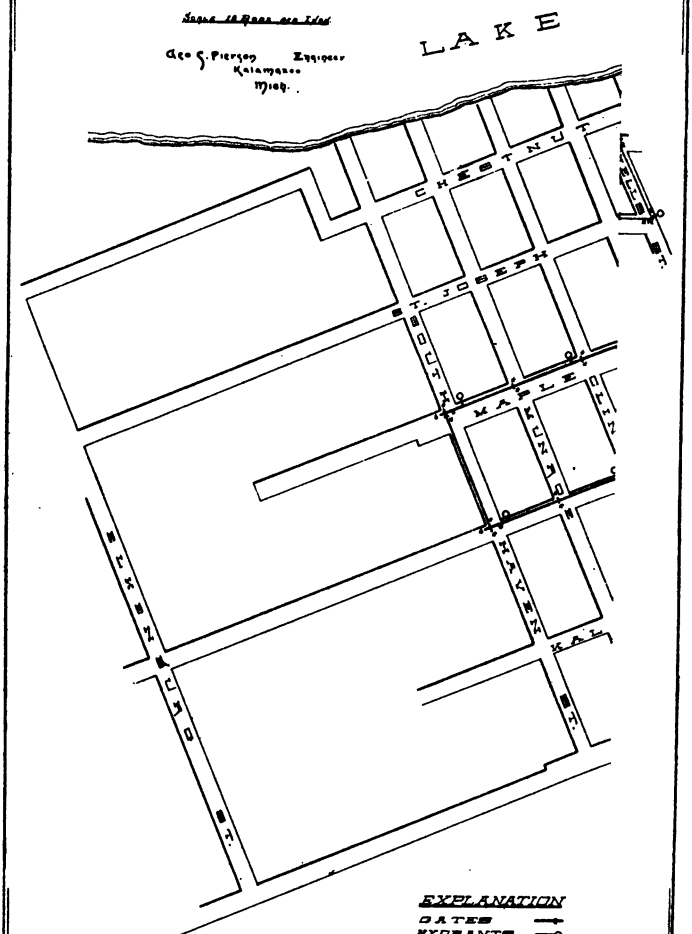
Aside from the method of obtaining a water supply there is nothing about the system particularly interesting to engineers, the details being, in the main, similar to those in other works of this class.

Attempts had previously been made to secure water from the strata bordering the Black river at points above the city, but without success. A suitable supply could be obtained from the lake by a long intake pipe extending out beyond the bars, but the estimates for this intake pipe, protected from the action of storms, which are severe at this point, were about $10,000. This sum, added to the cost of the stand pipe and pumping plant, left very little of the appropriation to be applied to the construction of pipe lines. The problem, then, was to secure at less cost a supply of water sufficient for present needs which could be supplemented in future as the demand arose, at reasonable cost and with certainty.

MAP
of the
WATER WORKS
South Haven
Mich
1888.

Scale 10 Rods per Inch

Geo S. Pierson Engineer
Kalamazoo
Mich.



EXPLANATION

GATES	
HYDRANTS	
12" PIPE	
10" "	
8" "	
6" "	
4" "	
3" "	

An examination of the lake shore revealed the following conditions:

The bed and shore of the lake is sand, rather fine, but well washed and permitting the passage of water with reasonable freedom. The shore rises from the lake at a slope of about three feet in 100 to the foot of the bluff, which is about 400 feet distant. The bluff, with the exception of a surface covering of about three feet of sand, is of tenacious clay as deep as it has been explored. The same clay formation extends under the beach of the lake at a depth of eight or ten feet below the surface of the sand and, continuing, extends under the bed of the lake at about the same depth.

Test wells were sunk at various points in the beach to the level of the stratum of clay, and from their behavior the following conclusions were drawn:

1. There was a slight upward inclination of the water surface from the level of the lake toward the foot of the bluff and consequently a movement of water from the sub-surface underlying the city towards the lake. Chemical analyses of the water from a series of wells arranged at right angles to the lake shore indicated that the water in the upper portion of the beach was polluted, and that the degree of pollution was less as the lake shore was approached.

2. The sand was sufficiently free to admit the passage of water in considerable quantities.

3. Vertical tubular wells of the ordinary form sunk in the shallow layer of sand above the clay must necessarily have short screens placed just above the clay in order to prevent the taking of air by the pumps when the water stratum is lowered by continuous pumping; and since a gang of wells in order to supply a sufficient quantity of water from this stratum must be at considerable intervals, it follows that the relative proportion of connecting pipes to screening surface must be large.

4. The farther from the bluff a supply of water could be secured the purer would the water be.

The following method of obtaining the supply was adopted:

At points thirty feet back from the water line of the lake pits were dug to water. Starting from these pits six-inch tubular wells were pushed out under the lake nearly horizontal, the in-

clination being about one inch per foot downward This is about the inclination of the stratum of clay underlying the bed of the lake. Where the tubular wells pass under the shore of the lake they are about three feet deep, and the depth below the sand gradually increases to five or six feet at the distance of about 125 feet. At about this distance from the shore line screens thirty feet long and as large as can be inserted in the six-inch casing are set. There are three of these wells at present and they are twenty-five feet apart and are connected by pipe lines parallel with the beach into a twelve-inch suction line leading to the pumps.

The history of subterraneous water supplies records many failures. The natural conditions essential to success are

1. A sufficient water shed from which the sub-surface water naturally flows to the point of supply or may be drawn to it by pumping.

2. Porous strata, both at the point of supply and remote from it, through which the sub-surface water may pass to the point of supply in sufficient volume.

The determination of the extent to which these conditions are present is generally a difficult matter. The action of test wells when pumped for a limited time is no guarantee of their performance under continuous pumping, and the fact that one test well supplies a certain quantity of water in a certain time is no guarantee that we can duplicate it by others at invervals of 50 or 100 feet or more which will correspondingly increase the supply even for a limited time; and if they do so for a limited time it may be that all are in a pocket of limited area which will be exhausted so much the sooner.

In the case in point, however, many of the uncertainties surrounding a work of this class are removed. The stratum in which the screens lie is comparatively accessible for examination. There is every reason to believe that it is uniform in character. Lake Michigan, which determines the static head above the screens will, so long as it stands above them, insure a constant supply of water to them, limited only by the capacity of the screens and the five feet of sand above them to convey it. Furthermore, wells placed at no great distance from one another horizontally will not sensibly encroach upon each other,

being supplied along the lines of least resistance or mainly through the sand *above* the screens. The supply can therefore be increased with certainty by additional wells.

If the lake recedes so as to uncover the screens, or the beach extends so as to force the open water beyond them, the wells can readily be extended, or additional ones can be put in to make up for the increased resistance due to the passage of the water through the sand for a greater distance.

The pumps are placed on foundations only seven feet above the level of the lake, in order to make the lift as low, and the action of the pumps as smooth as possible. The three wells readily furnish one million gallons of water per twenty-four hours under a vacuum of ten inches, as indicated by a gauge set on an air chamber thirteen feet above the level of the lake. The air chamber is taken off the suction line at a point seven feet above the level of the lake. Correcting for the lift of the pumps, and the friction in the suction line, the vacuum necessary to induce the passage of one million gallons of water per day through the sand and screens, is about two or three inches of mercury, or, say from 2.25 to 3.4 feet of water.

The water is uniformly clear, even during severe storms. No deposit of fine sand particles can be detected after the water has stood in a deep vessel for some time.

It was anticipated, that possibly the sand about the screens might become so compact by the action of the waves and the ice in winter as to impede the passage of water through it, and a by-pass is provided around the pumps so that the stand pipe pressure may be put upon the screens, and the current through them reversed. Each well is provided with a gate, so that it can be isolated from any, or all the others at will.

In the pump house are two direct acting duplex pumps of the Hughes pattern, each having a capacity of seven hundred and fifty thousand gallons each twenty-four hours.

There are two boilers fifty-four inches by twelve feet, with the usual attachments. Coal oil is used as fuel. It is stored in a special tank near the pump house, from which it is brought to the boilers by a pump. On the supply pipe from the oil tank is a meter. The flame from the burning oil strikes

against a bridge wall of fire bricks at the front of the boiler, which is laid up without mortar, and the bricks spaced about two inches, so that a portion of the flame passes through and against other similar walls. These bridge walls not only distribute the heat along the boiler with less damage to it, but after the fires go down, have a marked influence in keeping up the steam by the heat which they give off. The pumps are run about an hour each day, in the afternoon. Morning and evening, oil is burned under the boilers for about ten or fifteen minutes, and this prevents the steam pressure falling below thirty pounds at any time during the twenty-four hours.

The arrangement of the distribution system is shown on the accompanying map. The main leading from the pump house is ten inches in diameter, and the main connecting the stand pipe with the balance of the distribution is also ten inches in diameter. All hydrants except one are off from lines six inches in diameter or larger, and this one is fed by a four inch line from both directions, which is reinforced at the distance of a block in each direction by a six inch pipe.

Where the water main crosses Black river, it is laid fifteen feet below the surface of the water. It was desirable to test the river crossing before connecting it with the balance of the distribution system, and the following method was adopted.

The pipe was closed at one end above the water by a gate, and into the other end was calked an iron plug. Into this plug a ¾ inch water pipe was tapped, having a water meter and water gauge attached. Water was forced into the river crossing through the ¾ inch pipe, and the meter attached to it by a force pump until the desired pressure was obtained, and then the pump was operated enough to preserve this pressure. By this means could be detected the leakage in a given time at the required pressure.

The following lengths of pipe of the different sizes have been laid.

12	inch,	138	feet.
10	"	2646	"
8	"	3841	"
6	"	18420	"
4	"	4420	"

There have also been laid 2,705 feet of wrought iron pipe for domestic users only.

There are sixty-three hydrants. Some of those in the business portion of the city have independent nozzle cut off.

The stand pipe is fifteen feet in diameter, and one hundred feet high. The lower twenty feet is made of steel ½ inch thick, and at each twenty feet the thickness of steel is reduced 1–16 of an inch, the top course being ¼ inch thick.

The cost of the completed system was about $35,000.00.

MR. WILLIAMS: Do the ends of the tubular wells lie in the [sand?

MR. PIERSON: Yes, under the sand.

MR. WILLIAMS: How did you force them out?

MR. PIERSON: With jack-screws.

MR. WILLIAMS: What sized pipe did you use?

MR. PIERSON: Six-inch.

MR. WILLIAMS: How far below the water is the pipe?

MR. PIERSON: About five or six feet below the bed of the lake.

MR. WILLIAMS: What are these screens attached to?

MR. PIERSON: Pits were first dug, and from them pipes driven out into the lake by jack-screws; after the casing was driven out to that point, the screens were then inserted. Then the casing was drawn back, leaving the screens exposed.

MR. ROGERS: What was the expense of sinking these wells?

MR. PIERSON: The contract price was for $3,000, guaranteeing a supply of three-quarters of a million gallons in twenty-four hours.

MR. ROGERS: How was the river crossing laid below the bed of the river?

MR. PIERSON: The bed was dredged, and the pipe was laid with flexible joints. The pipe was all put together above the water and lowered to its place.

THE PRESIDENT: Did you complete your dredged channel all the way across before you laid the pipe?

MR. PIERSON: Yes, all the way across.

THE PRESIDENT: You did not have much current to contend with?

MR. PIERSON: Very little.

STREET GRADIENTS.

A. L. MARHOFF, BATTLE CREEK.

MR. MARHOFF: [This question has attracted my attention during the last summer more than any other question, from the fact that the city of Battle Creek, of 13,000 inhabitants, until last spring, had no person, who by ordinance or appointment could be called "City Engineer," and of course the streets, as regards grades, were in a very bad condition, only a very few grades having been recorded, and those of about twenty years standing.

I had no idea of edifying the members, in presenting this paper, but do so with the hope of getting information from those that have this work to do.]

Without a doubt there is no one thing entering into municipal engineering that affects the free holder and citizens of any municipality as the fixing of new grades and changing old grades that have become fixed by long usage. It no doubt has occupied the careful consideration of the older members of the profession as well as puzzling the younger members to a greater or less degree.

One of the most perplexing parts of the problem to the engineer is the part relating to intersections, including the elevations of block corners. While the part affecting the lot owner is the amount of cut or fill at the place of his abutting property, which from the nature of the case must receive the careful consideration of the city engineer. Where a city is located in a comparatively level section the problem is very much simplified.

There are three main objects to be attained: First to remove the surface water as soon as possible, second to reduce the percentage of grade to the least possible minimum without material injury to adjacent property, and third to make a street present a good appearance.

To accomplish the first, one should not have a minimum

grade of less than 3-10 of one per cent only in very extreme cases unless the street is paved with brick or asphaltum.

The second case should be governed very largely by the location and nature of the improvements that have been made along the line of the street. On a steep hill side where no improvements have been made to any great extent, or no improvement of any kind, a large cut will be admissible; but if the buildings and other improvements are of a permanent nature before the grade is established, as is too frequently the situation, one is almost, if not quite, compelled to accept the circumstances and make the best of the surroundings. It is therefore of great importance to all concerned to have a grade established and recorded as soon as possible after a street is laid out; then all improvements can be made to conform to said established grade.

The last and by far not the least is to have such a grade established as will give the street a good appearance. This part of the problem is governed largely as to whether the street is in the business or resident portion of the city. In either event the curb line should if possible be unbroken from CURB CORNER to CURB CORNER, but if impossible the grade should change at some property line, and if the change is very abrupt there should be adopted what might be called an easement grade, to prevent as much as possible a large deposit of sand and other easily moved material. By this means the trouble of continually removing the deposit after large showers could be greatly averted. This easement grade is of as much assistance in lessening the expense of caring for a street as are easement curves in railroad work in caring for the track and rolling stock.

And finally we have the street intersection problem, which has almost as many ways of solution as there are engineers engaged in municipal work. I find a very common way of disposing of it is to make all curb corners the same elevation. This has its advantages as well as its disadvantages. The only thing that seems to commend it is that it is an easy way of solving the problem, while it has the disadvantage of failing in being satisfactory on account of lack of drainage, unless what might be termed a compromise grade is adopted, which makes the finished work look as if the whole thing was done

by guess. A flat intersection also presents an ugly appearance, especially on a steep grade. Imagine yourself ascending a six per cent grade and when part way up, meeting with thirty or forty feet of level grade. It will invariably have the appearance of a descending grade. The best solution for resident portions of the city seems to be if the grade is three per

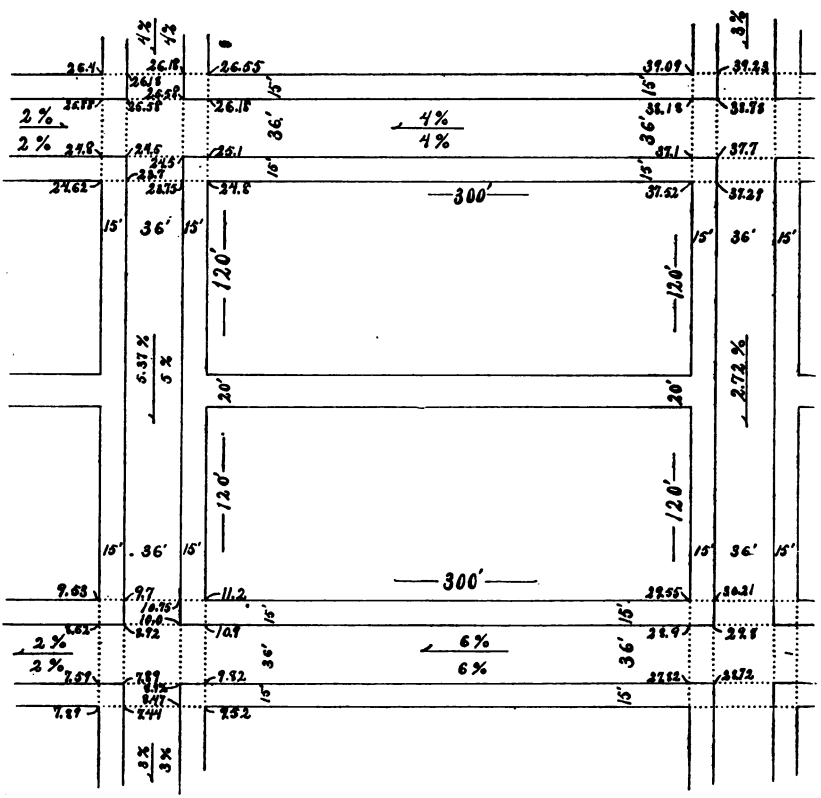


FIG. A.

cent or less, to carry the grade to the center of the intersecting street and make the change, if any, at that point, otherwise change the grade at the curb corner and making the maximum grade for the intersection three per cent. In the business portion of the city the maximum grade for intersection should for various reasons be less than three per cent. The elevation of block corners should in all cases be found by tak-

ing one-half of the sum of the two elevations of the curbs opposite the block corner, plus twice the elevation desired for a block line above the curb, which should be estimated at a 2½ per cent grade. For example: The elevations of the curbs opposite a given block corner are 10.75′ and 10.9′ respectively, and the curb line is fifteen feet from the block line, at 2½ per cent grade; this would make .375′, twice which is .75′. The sum of 10.75′ + 10.9′ + .75′ = 22.4′, which divided by 2 gives 11.2′, then 11.2′ would be the elevation of such a block corner.

The accompanying map (*Fig. A.*) shows a good way of recording such grades as well as better illustrating the plan.

MR. TEED: In his paper, Mr. Marhoff names over the requisites for street grades. and puts the appearance of the thing last. Now, I have been making street grades for about twelve years, and I find that after twelve years lapse of time those streets give the most satisfaction to the public as well as to myself, so far as I have any means of ascertaining, where we make the third requisite the first. I always aim, first to make the street look well, then figure the cost, and then the convenience of the people on the street—that I would put last, and of course if they don't object I don't take that into account at all, and if they do object, they have got to put it before the council, and before they get the matter through the council, their objection keeps growing smaller, and after the street is graded, and the people have the buildings raised up to the street, they forget the trouble and bother, and those streets that have been laid out with the first requisite—the general appearance of the street, are the streets that give the best satisfaction to-day.

I am thinking of residence streets of course, and that being the case, I would make no break at all with cross streets, and if cross streets come in, twist the ends so as to make the sidewalks fit. Fix it up to make it look as well as possible.

MR. SELLERS: What is your minimum grade?

MR. MARHOFF: Three-tenths of one per cent. What is the custom with reference to carrying the intersecting street back where you meet quite an inclination?

MR. SELLERS: The least minimum that I have been able to use is 5-10 of one per cent.

THE PRESIDENT: I don't suppose there is any established custom among engineers—each one has his own way. My practice was, to take the important streets, get as nice a grade as possible, and fit the cross street in as well as possible. I never could follow the same rule with regard to any two streets.

MR. GRANVILLE: Sometimes in carrying a grade up one street, especially where the grade is heavy, you finish your street and it has a nice appearance; but when you attempt to finish a cross street, which perhaps is just as important, you cannot make it present the same finished appearance. Another thing—I think the flat or level intersections are all right. They are good breathing places, and it gives you a better chance to finish most streets. It may be necessary to leave the block corners on the upper side of the hill higher than on the lower; but unless the grades are very heavy, it seems that nearly all intersections can be made about level.

THE PRESIDENT: I was speaking only with reference to streets having very heavy grades. The trouble is in first laying out our cities—instead of going straight up a bluff, the road should slant.

MR. SELLERS: What, as a usual thing, is your rule with regard to the width of a roadway?

MR. MARHOFF: From top to top of gutter, we make it thirty feet.

MR. ROGERS: Another question comes up right here: I think that cities lay out a good many streets at a needless width. A width that the traffic of the street will not demand for years, and thereby materially increases the cost of the pavement and cost of repairs, when a narrower street would answer all purposes.

MR. MARHOFF: That would be very well if you took only cost into consideration, but it is vastly more healthy to have wide streets, and a circulation and pure air, and safer in case of fire.

MR. ROGERS: I believe in having streets as wide as we can get them, but leave a lawn between the sidewalk and the curb.

MR. SELLERS: The question was with me, are they ever

made narrower than thirty feet, and if the rule is wider, I want to know it.

MR. GRANVILLE: In Saginaw, the majority are sixty-six feet in width. By ordinance, the earth streets are made with sidewalks fourteen feet—that would give us thirty-eight feet from the top of the ditch, as you term it, on one side, to the top of the ditch on the other side, leaving probably twenty-six to twenty-eight feet for the road bed proper. Of course, when it comes to paving or graveling, the widths are changed.

MR. SKEELS: In Grand Rapids the sidewalks run from twelve to sixteen feet, and fifty foot streets are the rule, with ten foot sidewalks.

DIGEST OF LEGAL DECISIONS.

The following digest of legal decisions of interest to engineers is compiled from the reports published by the West Publishing Company, by permission:

ADVERSE POSSESSION.

1. To entitle a party to claim by adverse possession he must have made an actual entry upon the lands and occupied the same as owner, but such occupancy may be continued by his agents and servants.—Omaha & Florence Land & Trust Co. v. Parker, (Neb.) 51 N. W. 139.

2. In an action for partition of lands descended, a son-in-law of decedent set up title to a part of the lands occupied by him by adverse possession, and that the same never belonged to decedent. *Held*, there being evidence to show that the son-in-law was induced by decedent to move on the land in question under an agreement that his wife should receive the same on division of decedent's estate, that a verdict against the son-in-law should not be disturbed.—Townsend v. Boyd, (Ky.) 18 S. W. 365.

3. The owner of land, through which a public highway was opened, built a fence across the line, but placed a gate at the entrance of the road, and acknowledged that he did not cultivate the land up to the line because there was a public

road there, and for thirteen years there was travel on the highway without objection by such owner. *Held*, that a claim of adverse possession by him was not justified.—Hempstead v. Huffman, (Iowa) 51 N. W. 17.

4. Where land was given under a verbal gift, and the donees entered thereon, and held the land as their own, and adversely to the claims of the donor, for more than fifteen years, the donees acquired a perfect title.—Spradlin v. Spradlin, (Ky.) 18 S. W. 14.

5. In an action by an owner of land abutting on the west side of a street for damages from the occupation of a portion of it, east of the center line, by railroad tracks, defendant proved two deeds in due form, executed and recorded in 1873 and 1875, respectively, and purporting to convey to it the blocks on the east side of the street. Plaintiff produced three affidavits, in which each affiant swore that, in his opinion, the grantors never owned the blocks, and that defendant obtained the deeds fraudulently, for the purpose of acquiring color of title; but no fact was stated or proven in support of their opinions. *Held*, that the deeds gave defendant color of title, and that its adverse possession under them for ten years established its right to maintain its tracks against any person claiming an interest in those blocks.—Sinnot v. Chicago & N. W. Ry. Co., (Wis.) 50 N. W. 1097.

6. Possession under a tax deed is possession under color of title, sufficient to support a plea of adverse possession of lands beyond the statutory period within which an action must be brought to recover the same.—Smith v. Johnson, (Mo. Sup.) 18 S. W. 21.

7. The grantee of land conveyed under a tax-deed immediately entered thereon and enclosed it by a fence, except a gate-way, and claimed title. Shortly afterwards he sold the land. His grantee at once entered, and began to improve the land, and built a house thereon. Afterwards the land was conveyed to defendants, who have ever since resided thereon. Plaintiff contended that the evidence was insufficient to establish adverse possession, in that the gate-way was not closed, and that there was no verbal expression as to how defendants and defendants' grantor claimed to occupy the land. There was no question but that they had occupied the land more than five years. *Held* sufficient to prove all that is required by Code Civil Proc. § 322, providing that the possession of land for five years by one entering under a witten instrument purporting to convey it shall be deemed adverse, and section 323, providing that, for the purpose of constituting an adverse possession, land is deemed to have been possessed where it has been improved.—Kockemann v. Bickel (Cal.) 28 P. 686.

8. One who dedicates land to the public cannot subsequently acquire it by adverse possession.—Archer v. Salinas City, (Cal.) 28 P. 839.

9. Land dedicated to a public use cannot by adverse possession be acquired by individuals, though the title is held by a municipal corporation.—Yolo Co. v. Barney, 21 P. 833, 79 Cal. 375, followed.—Board of Education of City and County of San Francisco v. Martin, (Cal.) 28 P. 799.

10. Where land was reserved by a municipal corporation for public purposes, it cannot be divested thereof by adverse possession.—Yolo Co. v. Barney, 21 P. 833, 79 Cal. 375, and Board v. Martin, (Cal.) 28 P. 799, followed.—City and County of San Francisco v. Bradbury, (Cal.) 28 P. 803.

11. A deed to a tenant in possession from one who has no title to the land is void, and insufficient as a basis for adverse possession. 11 N. Y. S. 108, affirmed.—McRoberts v. Bergman, (N. Y. App.) 30 N. E. 261.

12. The fact that the owner of a lot had it surveyed, built a shanty upon it, and verbally gave the lot to another, and put the donee in possession, does not constitute the color of title in the donee; and, as color of title is necessary in order that adverse possession of a part of land shall draw to it constructive possession of the whole, the donee by actual adverse possession of a part only of the lot, though she claimed to own the whole, would not acquire title to the whole.—Allen v. Mansfield, (Mo. Sup.) 18 S. W. 901.

13. A quitclaim deed is sufficient color of title to support a plea of title by limitation. Parker v. Newberry, (Tex. Sup.) 18 S. W. 815.

14. A woman, finding a small island in Westchester creek, near New York city, unoccupied, entered thereon without claim or color of title, recorded or otherwise, erected buildings thereon, and remained in possession for twenty years. *Held*, that being a mere squatter, she could not obtain title by adverse possession.—In re City of New York, (Supt.) 18 N. Y. S. 82; In re Blizzard, Id.

15. Title to land is acquired by adverse possession for twenty years under a void tax-title.—Harrison v. Spencer, (Mich.) 51 N. W. 642.

16. Where the owner of an estate for life procures the issuance of a tax-deed to himself, and then conveys the land by warranty deed, possession taken thereunder is adverse to that of the remainder-man, since the warranty deed is color of title in fee.—Lewis v. Pleasants, (Ill. Sup.) 30 N. E. 323.

17. A deed from one to whom a tax-deed, regular on its face, has been issued, constitutes color of title, within the meaning of the statute of limitations, where the grantee takes

it in good faith, without knowledge of any defects, even though the tax-deed was not supported by any judgment, and the person to whom it was issued was under legal obligations to pay the taxes for which it was sold.—Lewis v. Pleasants, (Ill. Sup.) 30 N. E. 323.

18. In tresspass to try title to land lying north of what was called the southern fork of a creek, where defendant claims under a deed from plaintiff, the statute of limitations was of no avail to defendant, though it was shown that he had had possession for the requisite period, where the deed under which he claimed conveyed no land north of the southern fork. —Bassett v. Martin, (Tex. Sup.) 18 S. W. 587.

19. A creditor secured by a deed of trust purchased the land at a void sale thereunder, and the trustee made him a deed purporting to convey it in fee, and such purchaser afterwards conveyed the land in fee to another, and he and his alienee held actual possession, claiming the land in their own right, for the period of the statute of limitations. *Held* that the possession gave title, and barred the right of the grantor in the deed of trust to redeem.—Swam v. Thayer, (W. Va.) 14 S. E. 423; Same v. Young, Id. 426.

20. Whether the planting of trees upon a piece of land, and its use by cutting grass and pasturing cattle thereon during each year of the occupancy, constitutes a practically continuous, exclusive and hostile possession, such as will give title by adverse possession without color of title, is a question for the jury.—Sauers v. Giddings, (Mich.) 51 N. W. 265.

21. The word "hostile," when applied to the possession of an occupant of real estate holding adversely, is not to be constructed as showing ill will, or that he is an enemy of the person holding the legal title, but means an occupant who holds, and is in possession as owner, and therefore against all other claimants of the land. Ballard v. Hansen, (Neb.) 51 N. W. 295.

22. In order to obtain title by adverse possession without color of title, it is not necessary that the land shall be actually inclosed.—Sauers v. Giddings, (Mich.) 51 N. W. 265.

23. An actual entry upon, and possession of land though in fact tortious and without color of paper title, if under a claim of right thereto, in opposition to, and inconsistent with that of the true owner, may ripen into title by adverse possession; and continued acts of ownership upon the property, occupying, using and controlling it as owner, is an assertion of a claim of title, and sufficient notice of such claim to the owner.—Village of Glencoe v. Wadsworth, (Minn.) 51 N. W. 377.

24. In ejectment, when it appears that defendent held

possession of land for over twenty years, claiming up to a certain fence which was supposed to be on the dividing line, whereas in fact, the fence encroached several feet on plaintiff's land, defendent acquires title by adverse possession, though he admitted on the trial that he claimed to the fence because he thought it was the true line.—Battner v. Baker, (Mo. Sup.) 18 S. W. 911.

24. To affect the disseisin of the real owner of the land, the entry, under a duly registered deed from one having no title, must be followed by an open, notorious, exclusive possession, continued uninterruptedly during the statute period.—Roberts v. Richards, 24 A. 425, 84 Me. 1.

25. The essential use and occupation of land by one claiming adversely must be of such unequivocal character as will reasonably indicate to the true owner visiting the premises during the statute period that, instead of suggesting the probable invasion of a mere occasional trespasser, they unmistakably show an asserted exclusive appropriation and ownership.—Roberts v. Richards, 24 A. 425, 84 Me. 1.

26. Where plaintiff relies on possession alone, it must be actual, and not constructive; and the fact that he made one crop on the land is insufficient.—Conn v. Franklin, (Tex. Sup.) 19 S. W. 126.

27. Where coterminous owners of land establish a boundary line, and take possession to the line so agreed on, and one of them erects valuable improvements thereon, and holds quiet and peaceable possession thereof, without objection from the other coterminous owner or his grantees, for a period of more than eight years, such line is binding on them, and those holding under them.—Idaho Land Co. v. Parsons, (Idaho) 31 P. 791.

28. No one can obtain a right in a public highway by adverse use.—Wolf v. Town of Sullivan, (Ind. Sup.) 32 N. E. 1017.

29. Act May 18, 1807, provides that the first seven feet of the sidewalk space of a street in the city of Detroit shall be reserved for erecting porches in front of houses, for grass plat, and for other purposes of utility and ornament, according to the inclination of the proprietor. Act Nov. 7, 1815, provides that no erection on this space shall exceed fifty inches in height, and that every person placing a fence on the front line of the ten feet shall also place another fence on the rear line of said ten feet, along the line of his lot, and said ten feet shall not be severed from the street. *Held*, that where an owner built his house so that it stood partly on a strip claimed to be within the limits of the street, and enclosed the whole strip together with his lot, not separating it therefrom by a fence, he

was not acting within the license of such acts; and his possession of the strip was adverse to the city.—Flynn v. City of Detroit, (Mich.) 53 N. W. 815.

30. When there has been an entry upon land under color of title by deed, although the actual settlement and improvements are on only a small portion of the tract, yet, when there is nobody in possession of the rest of the tract the law presumes the entry to be co-extensive with the grant. Ellicott v. Pearl, 10 Pet. 412, followed.—Smith v. Gale, 12 S. Ct. 674.

31. A person who has actual possession of a part of a tract of land described in his deed has constructive possession of the whole.—Porter v. Miller, (Tex. Sup.) 19 S. W. 467.

32. Where there is no paper giving color of title defining the extent of adversary possession, but it is only under claim of title, the possession will be limited to inclosure, clearing, or actual improvement.—Jarret v. Stevens, (W. Va.) 15 S. E. 177.

33. The possession of a portion of a street by a railroad company entering under authority given by its charter is not adverse to the public, where there is no exclusion of the public use.—Village of Wayzata v. Great Northern Ry Co., (Minn.) 52 N. W. 913.

34. To obtain title to land by prescription of thirty years, the intention of possessing as owner as well as the possession of the land must be proven, and it is not enough to show cultivation of the land.—Clemens v. Myer, (La.) 10 So. 797.

35. In ejectment between owners of coterminous subdivisions of a lot of land in a city, plaintiff claimed under a conveyance describing his subdivision as being "about twenty-nine feet" in width. Conveyances of the other subdivisions of the lot by metes and bounds demonstrated the fact that plaintiff's lot was only twenty-seven feet in width. Plaintiff has always supposed and claimed that his lot was twenty-nine feet wide, but had never been in the occupancy of nor claimed any of the two feet beyond the true boundary. *Held* insufficient to support a claim of title to such strip of two feet by adverse possession.—Kunze v. Evans, (Mo. Sup.) 18 S. W. 36.

BOUNDARIES.

1. A fresh water stream, which at low tide flows through a tidal channel, from which the tide wholly ebbs, does not constitute "low water mark" within the meaning of the colony ordinance of 1641–47, providing that the title of owners of land adjoining tidal waters shall extend to "low-water mark," and such a channel is not a boundary to the land of the adjoining proprietors. FIELD, C. J. and KNOWLTON and LATHROP, JJ,

dissenting,—Tappan v. Boston Water Power Co., (Mass) 31 N. E. 703; Brown v. Same, Id.

2. Flats situate in a tidal river at a point in its course above the line of low tide, are to be divided among the adjoining properties, by drawing lines from the terminal of the latter on the banks at the ordinary stage of water to and at right angles with the center line of the river.—Tappan v. Boston Water-Power Co., (Mass.) 31 N. E. 703; Browne v. Same Id.

3. Plaintiff claimed under a deed describing the land conveyed as beginning at the "sea" on A's line, thence south on the said A's line to the highway; thence west on the highway ten rods to the stake; thence north to the "shore" parallel with said A's line; thence east to the first bounds mentioned. It did not appear that the grantor intended to retain the adjoining as distinct from the upland. *Held*, that the deed conveyed to plaintiff, the flats or shore, with the upland.—Snow v. Mt. Desert Island Real Estate Co., 24 A. 429, 84 Me. 14.

4. Where land bounded southerly on the sea shore, and extending one league in width on each side of a river at its mouth, was granted, together with the island of Mount Desert, and "other islands on the forepart of said two front leagues," in ascertaining the location of the "other islands" mentioned, the rule governing "flats" between adjoining owners of land situated on the seashore does not apply.—Roberts v. Richards, 24 A. 425, 84 Me. 1.

5. On a question of boundary between two surveys, (plaintiff's land and survey No. 8,) the evidence as to the location of the calls in the field notes was conflicting. The jury was instructed, that if they found that survey No. 8 was located on the ground a certain distance "west from the west line of F. county school land, as claimed by plaintiff to find for plaintiff." *Held*, that the instruction was error, as it confined the consideration to one connection called for by the field notes, in disregard of evidence of other calls.—King v. Mansfield, (Tex. Sup.) 19 S. W. 858.

6. It is not error in ascertaining the true locality of the back line of a survey fronting, with established corners, on a river, to reverse the calls of the survey, if it is found that thereby the decrepancy in the area of the survey is lessened, and the back line falls along the line of the alleged conflicting survey, which is, moreover of prior date; the recognized rule being, that the beginning corner in the certificate of survey is of no higher dignity than any other corner.—Miles v Sherwood, (Tex. Sup.) 19 S. W. 853.

7. Where, upon a town plat, the only boundary for part of a street on one side of a navigable lake, the street extends

to low-water mark.—Village of Wayzata v. Great Northern Ry. Co. (Minn) 52 N. W. 913.

8. Where there is a decrepancy between the survey of an addition to a town, as shown by the plat, and as the lines were actually run, the purchasers of lots described merely according to their numbers, take title according to the lines actually run, when they can be ascertained.—Root v. Town of Cincinnati, (Iowa,) 54 N. W. 206; Kerr v. Same, Id.

9. Where it is shown that purchasers of lots in an addition to a town, took possession and fenced their lots soon after the survey was made, and that the person who made the plat pointed out the bounds of the lots, it will be presumed that their possession was taken according to the lines of the actual survey.—Root v. Town of Cincinnati, (Iowa,) 54 N. W. 206; Kerr v. Same, Id.

10. The fact that a deed described the property conveyed as commencing at a known monument on the shore of a pond, and running thence "along said pond," does not show an intention to convey only to the shore. 11 N. Y. S. 87, reversed. —Gouverneur v. National Ice Co., (N. Y. App.) 31 N. E. 865.

11. A deed of land bordering on a small non-navigable lake or pond is presumed to convey title to the center of the lake or pond, unless the contrary appears.—Wheeler v. Spinola, 54 N. Y. 377, distinguished. 11 N. Y. S. 87, reversed.— Gouverneur v. National Ice Co., (N. Y. App.) 31 N. E. 865.

12. A deed described the land conveyed as bounded by the "northeasterly side" of W. street, "together with the free and common use, right, liberty and privilege of said * * * W. street." *Held*, where the whole of such street was on the grantor's land, that the grantee took the fee only to the side line of the street, with a right-of-way over the whole street.— Hobson v. City of Philadelphia, (Pa. Sup.) 24 A. 1048.

13. Gen. St. 1889, par. 1836, provides that, whenever landowners shall desire to establish permanently the boundaries of their lots, they shall notify the county surveyor, who shall forthwith notify all parties interested of the time of making the survey. He shall make the survey at such time, and file the evidence taken, and a plat and notes of the survey, in the office of the register of deeds, within ten days after the completion of the survey. *Held* that, where the surveyor made only a partial survey at the time named in the notice, and completed it six weeks later, without notice to a party interested, the survey did not comply with the statute; and in an action in the nature of trespass, the boundary line being at issue, the survey was not conclusive, and the exclusion of evidence as to the location of the line prior to the survey was error.—Schwab v. Stoneback, (Kan.) 31 P. 142.

14. Where the calls in a conveyance of land are for two corners, one at high water mark on the bank of a stream, and the other at the stream, and there is an intermediate line extending from one such corner to the other, the stream is the boundary, and all riparian rights pass, unless a different intention of the parties is shown by either their conduct or the conveyance.—County of St. Clair v. Lovingston, 23 Wall. 46, and Railroad Co. v. Schurmeier, 7 Wall. 272, followed. 47 F. 757, affirmed.—Whitehurst v. McDonald, (C. C. A.) 52 F. 633.

15. Where a street, as abutting on which a lot was conveyed, had been surveyed and its location designated by stakes set at the corners of the lot when the deed was made, the boundary of the street forms the boundary of the lot, though the measurements given in the deed would include a portion of the street, whether the grantee had actual knowledge of the stakes or not.—Foley v. McCarthy, (Mass.) 32 N. E. 669.

16. Courses and distances must yield to the demands of an actual survey when the evidence determines the fact of such survey; so that, where the surveyor's field notes show actual surveys on the ground, and the lines and corners thereof are called for as contiguous, and evidences of such surveys are still found which reasonably indicate an excess in the distance of the lines of 260 varas in 7,116 varas, at the date of the survey, (1856,) considered trifling, and a slight variance of seventy-five varas in the course, these discrepancies should not overcome the other evidence pointing to the fact that the surveys are contiguous.—Graham v. Dewees, (Tex. Sup.) 20 S. W. 127.

17. Where a survey is made without legal authority, copies of the field notes thereof, though certified from the general land office, are inadmissible.—Von Rosenberg v. Haynes, (Tex. Sup.) 20 S. W. 143.

18. In a dispute as to the boundary line between adjoining proprietors, testimony that a former owner of the elder survey, who was one of the original surveyors of the tract and helped to locate the corners, and who has since died, pointed out to witness a certain place as a corner, is admissible.—Beal v. Asberry, (Tex. Sup.) 20 S. W. 115.

19. The expressions, "middle of the Mississippi river" and "the center of the main channel of that river," as used respectively in the enabling acts under which the states of Illinois and Wisconsin were admitted into the Union, and "middle of the main channel of the Mississippi river," as used in the enabling acts of Missouri and Iowa, all being descriptive of the boundaries of those states, are synonymous terms; and mean the middle of the main navigable channel, or channel most used, and not the middle of the great bed of the stream, as de-

fined by the banks of the river.—State of Iowa v. State of Illinois, 13 S. Ct. 239.

20. Where the description in a deed, after following the line of another tract to a certain point, contains a clause "thence with that line to a stake on the west bank of the branch," it should be construed as intending to follow the boundaries of such tract, though the courses change before reaching the branch, and though the branch would be reached at a less distance by following an extension of the first course from the point in question.—Buckner v. Anderson, (N. C.) 16 S. E. 424.

21. The locative calls in a patent, in accordance with which the survey is admitted to have been actually made on the ground, control more general calls as to the county, and the direction and distance of the land from certain well known points.—Minor v. Kirkland, (Tex. Civ. App.) 20 S. W. 932.

22. Plaintiff claimed that, under a patent granting the "east half" of a quarter section, his land extended to a north and south line dividing the quarter section in equal halves, while defendant claimed through a patent granting the west half of the quarter, "according to the official plat of the survey," which placed the division line fifteen feet east of the line claimed by plaintiff. The quarter section was fractional, and according to the official plat the west half contained ninety acres, while the east half contained but eighty. *Held*, that as the official plat controlled the identification of lands granted by government patents, plaintiff had no title to the strip of land in dispute.—Turner v. Union Pac. Ry. Co., (Mo. Sup.) 20 S. W. 673.

23. Where, in trespass to try title, there is a conflict in the calls of a railroad survey under which plaintiff claims, parol testimony is admissible to show where the metes and bounds of the surveys were actually run and marked upon the ground.—Minor v. Kirkland, (Tex. Civ. App.) 20 S. W. 932.

24. In an action to obtain possession of land, where a controversy arises as to which one of two branches is meant by a clause in a deed which states "thence with that line to a stake on the west bank of the branch," and the evidence is conflicting as to whether there is in fact any branch crossing such line at the point claimed by plaintiff, the question as to which branch was intended was properly submitted to the jury.—Buckner v. Anderson, (N. C.) 16 S. E. 424.

25. Where a controversy arises as to which one of two branches is meant by a clause in a deed which states "thence with that line to a stake on the west bank of the branch," though there be evidence that the parties agreed by parol where the true boundary ran, after the exe-

cution of the deed, it is proper for the court to refuse to instruct the jury that by such verbal agreement the parties could alter the boundaries as fixed in the deed, and would be estopped from disputing the new location so agreed upon.—Buckner v. Anderson, (N. C.) 16 S. E. 424.

26. Under Rev. St. U. S. § 2396, which provides that the boundary lines actually run and marked in the surveys returned by the surveyor general shall be established as the proper boundary lines of the sections or subdivisions for which they are intended, a resurvey made three years after a patent is issued cannot, in the absence of fraud, change the corners and boundaries as established by the original survey so as to affect the patentee's rights.—Spawr v. Johnson. (Kan.) 31 P. 664.

27. Where objects, natural or artificial, are called for in the field notes of official surveyors, the presumption is that such objects actually existed.—Kuechler v. Wilson, (Tex. Sup.) 18 S. W. 317.

28. In a deed of conveyance, the boundary lines of the granted premises, designated by courses and distances, starting from a definite place of beginning, disclosed no error or inconsistency until the last line was reached, which was to run to the place of beginning;" but the given course and distance, would not bring it to that point, nor complete the enclosure of any land. *Held*, that the course and distance of the last line should be rejected as erroneous, and effect be given to the more certain designation, "thence to the place of beginning." —Owings v. Freeman, (Minn.) 51 N. W. 476.

29. Where a fence is built between two lots on the line indicated by the first survey, and the lots are purchased in reliance on the correctness of such line, the purchasers are entitled to maintain it as a boundary, even though a subsequent survey shows it to be wrong. Flynn v. Glenny, 17 N. W. 65, 51 Mich. 580, followed.—Le Compte v. Lueders, (Mich.) 51 N. W. 542.

30. Plaintiff's predecessor in title, through mistake as to the true boundaries of land purchased by him, built his fence so as to include other land of his grantor not conveyed by the deed. The land so inclosed was occupied and cultivated by plaintiff and his predecessor as a homestead, for more than forty years. Code Civil Proc. N. Y. § 327, provides that "for the purpose of constituting adverse possession by a person claiming title not founded on a written instrument, the land is presumed to have been possessed and occupied * * * (1) where it has been protected by a substantial enclosure; (2) where it has usually been cultivated and improved." Section 368 provides that such possession for twenty years will overcome the presumption in favor of the owner of the legal title.

Held, that plaintiff has a good title by adverse possession. 12 N. Y. S. 693, affirmed, without opinion.—Eldridge v. Kenning, (N. Y. App.) 29 N. E. 1028.

31. In trespass for cutting down timber; it appeared that the division line between plaintiff and defendant had been surveyed by courses and distances; that, commencing at the point specified, and running either as claimed by plaintiff or by defendant, some of the distances, where no monuments were specified in the description, must be disregarded in order to return to the point started from. *Held*, that this raised a latent ambiguity to solve which oral testimony was admissible. —Rugg v. Ward, (Vt.) 23 A. 726.

32. In ejectment arising out of a boundary dispute, both parties claimed to a certain old line, and both relied on adverse possession; defendants contention being that there was a jog in the old line. Plaintiff having given the evidence of adverse possession for the prescriptive period, defendent introduced evidence that he himself had been in adverse possession to an old board fence, which remained upon the ground until a few years before the trial, and that this fence was located on the line of the jog claimed by him. *Held*, that it was proper for plaintiff to show in rebuttal that this fence stood upon a straight line with the rest of the boundary.—Wineman v. Grummond, (Mich.) 51 N. W. 509.

33. In ejectment arising out of a boundary dispute, where both parties claim to a certain old line, and both rely upon adverse possession, it is competent for plaintiff to introduce the title deeds for both himself and defendant, the boundary being therein described by reference to the old line by name, since they tend to show the location of the respective lots, and that the question at issue is as to the true location of the old line named therein.—Wineman v. Grummond, (Mich.) 51 N. W. 509.

34. A grant of lands bounded by navigable tidewater carries no title to land below high-water mark.—DeLancey v. Piepgras, (Sup.) 17 N. Y. S. 681.

35. Occupants of government land caused the same to be platted as a town-site, with a street along the shore of a navigable lake. Thereafter this town-site was entered and purchased, and title thereto obtained by a judge of the district court, as provided by act of congress of May 23, 1844. In the execution of his trust, said judge conveyed to one of the beneficiaries a lot fronting upon the street before mentioned, describing the same in accordance with the town plat. *Held*, that the fee title, subject to the public easement, to the entire street to low-water mark, including all the riparian rights, and not merely to the middle of the street, passed to the

grantee, and on a conveyance by him by the same description passed to his grantee.—Wait v. May, (Minn.) 51 N. W. 471.

Where monuments mentioned in a deed are identified, they control both courses and distances given, whether they were seen by the parties to the deed or not.—Anderson v. Richardson, (Cal.) 28 P. 679.

37. Where the boundaries of a survey cannot be located by its own calls and field-notes, they may be established by the field-notes of adjacent surveys.—Kuechler v. Wilson, (Tex. Sup.) 18 S. W. 317.

38. Where a junior survey was not made on the ground, and the calls are for the surrounding surveys, the lines of such surveys will be the lines of the junior survey.—Kuechler v. Wilson, (Tex. Sup.) 18 S. W. 317.

39. The mere fact that the owner of land, desiring to break it, calls upon the owner of adjoining land to point out the boundary between them, and that the latter indicates what he supposes to be the line, does not create an estoppel against such adjoining owner to claim the true line, if different from the one pointed out.—Heinz v. Cramer, (Iowa,) 51 N. W. 173.

40. On an issue as to the true location of the western boundary line of a certain claim, the evidence showed that the line contended for by defendent was identified by the first surveyor of the claim as the line run by him, which line the government surveyor followed in his survey; that it substantially agreed with the natural calls in the field-notes of the government survey; that it was traceable by marks and blazes on the trees; that it agreed substantially with the reputed line as evidenced by certain fences; and that it intersected the south-eastern corner of the claim adjoining on the west, while the line contended for by plaintiffs ran some sixty feet further east. Plaintiffs' contention was supported only by the fact that what they claimed to be the south-western corner was the north-western corner of the claim adjoining on the south, which corner was intended to be identical with the southern terminus of the line in dispute, and which was within six feet of the correct distance from the south-eastern corner of the claim on the north according to the field-notes. But the claim on the south was located subsequently to the government survey before mentioned. *Held*, that the evidence showed defendants' contention to be the true line.—Van Dusen v. Shively, (Or.) 29 P. 76.

41. In an action of trespass for cutting timber, where the location of the dividing line between the parties is relevant, the testimony of the county surveyor that he ran the line pending the suit, that defendant was present when this was done, and that a certain map of the survey is correct, is admissible evidence for plaintiff, notwithstanding the surveyor also testifies

that the work was done in the course of processioning the land in accordance with the statute on that subject.—Gunn v. Harris, (Ga.) 14 S. E. 593.

42. In ejectment arising out of a boundary dispute, where both parties claim to a certain old line, and both rely upon adverse possession, the defendant's contention being that there was a jog in this old line, it was competent for an experienced surveyor, familiar with the property, to testify that he had surveyed the line some time in the 50's and found it to correspond with certain maps then in existence, and then to testify by the aid of those maps that the line was straight, instead of containing a jog, although such maps were not shown to be authentic.—Wineman v. Grummond. (Mich.) 5 N. W. 509.

43. Where the description in a deed is by metes and bounds, which are complete in themselves, and which are so made as to exclude a certain road, a reference to the road for the purpose of designating the point from which the description starts and the course of a line therefrom does not show an intention to make the road the boundary of the land, except as it coincides with the description in the deed; and the grantee, therefore, is not entitled upon the discontinuance of the road as a public way, to claim an easement therein, as appurtenant to the premises against the grantor.—Lankin v. Terwilliger, (Or.) 29 P. 268.

44. Where there is a conflict as to the location of land by a survey, but two corners thereof can be definitely identified, the courses and distances may be ascertained from the field-notes, and the entire survey constructed therefrom; and in such case the distance and quantity must yield to course.—Rand v. Cartwright, (Tex. Sup.) 18 S. W. 794.

45. A monument established by the government surveyors as the true corner of sections will control courses and distances.—Brown v. Morrill, (Mich.) 51 N. W. 700.

46. Where, in an action to recover possession of land, the evidence is conflicting as to the true location of a station, which is described as a natural monument, and is located in a different place by the courses and distances, the natural monument will control.—Stoll v. Beecher, (Cal.) 29 P. 327.

47. Where the public have only a right of way over a public street, a conveyance of the abutting land, describing it as "bounded by" such street, includes the land to the center of the street.—Firmstone v. Spaeter, (Pa. Sup.) 25 A. 41; In re Kimber's Estate, Id.

48. Where, in a suit by certain property holders against a city, the evidence shows an uncertainty as to the direction in which one of the boundary lines of the city should run, but it appears that the boundary claimed by the city has been acqui-

esced in by both parties for over twenty years, and until the time of bringing the suit, such boundary will be considered the correct one.—Belknap v. City of Louisville, (Ky.) 20 S. W. 309.

49. A mere parol agreement of adjoining land-owners as to the boundaries between them, which changes the legal construction of the title deed, is not binding on subsequent purchasers.—Shaffer v. Hahn, (N. C.) 15 S. E. 1033.

50. Where the owners of land convey the same, bounding it by the line of a highway, parol evidence is admissible to show whether, by such description, the parties meant the surveyed line of the highway, or the line as actually used and occupied.—Wead v. St. Johnsbury & L. C. R. Co., (Vt.) 24 A. 361.

51. Where, in a suit to establish a section corner, the only objections to the commissioner's report are as to his findings, the court may, after sustaining the objections, establish the corner without again referring the case to the commissioner,—Yocum v. Haskins, 46 N. W. 1065, 81, Iowa, 437, distinguished. Doolittle v. Bailey, (Iowa,) 52 N. W. 337.

52. Where, in a suit to establish a section corner, the evidence shows that it was located at a certain point, the court should establish the corner at that point, even though such point is not equidistant from the section corners on either side of it.—Doolittle v. Bailey, (Iowa,) 52 N. W. 337.

53. The word "adjoining," in the description of premises conveyed, means "next to," or "in contact with," and excludes the idea of any intervening space. The description of the premises granted as "adjoining the Atlantic ocean," with the additional words "bounded on the ocean," carries title to the line of ordinary high water, with all the incidents of riparian ownership upon tidal waters.—Yard v. Ocean Beach Ass'n, (N. J. Err. & App.) 24 A. 729.

54. In establishing section lines, corners shown to have been originally made by government surveyors are conclusive, and shall be accepted as the true corners, no matter how inaccurately they may have been originally established.—Town of Liberty v. Burns, (Mo. Sup.) 19 S. W. 1107.

55. Where the monuments, or objects, or marks called for in a deed have been obliterated, their former site or location must be established with reasonable certainty, in order that they shall prevail over the lines established by explicitly given courses and distances, or to throw an evident error of description by courses and distances into the second boundary line as given, which otherwise would be charged to the fourth or last line, and correct the description by rejecting the given courses and distances, and bringing the last line to the terminus defi-

described in a deed from P. to O., recorded on a specified page of a specified public record, to agree with the metes and bounds made by one C., sufficiently identifies the land.—Overand v. Nenczer, (Tex. Sup.) 18 S. W. 301.

11. The owner of a farm of 300 acres, in which was a garden 100 feet square, immediately behind his house, granted a railroad company a right of way across his farm, "provided the road runs at back of garden." This clause was inserted in the deed because the grantor was dissatisfied with a preliminary survey which had made the line of the road run through the garden. *Held*, that the deed gave the company no right to construct its road through the garden.—Knoxville, C. G. & L. R. Co. v. Beeler. (Tenn.) 18 S. W. 391.

12. Where a deed describes the tract conveyed as bounded, north fifty-six feet by a certain street, "east two hundred feet by other land of said grantors on a passage-way," south fifty-six feet by certain land, and west two hundred feet by another street, but it appears that no passage-way in fact exists, the deed is to be construed as conveying a tract fifty-six feet wide, irrespective of the passage-way mentioned.—Treat v. Joslyn, 29 N. E. 653, 139 Mass. 94.

13. In an action to establish a disputed boundary line, it appeared that the person from whom plaintiff derived title, settled on the public domain with the intention of acquiring three hundred and twenty acres thereof. He finally received a certificate therefor, in which the land was described only by courses and distances from an initial point, and as so described contained 322.89 acres. On this certificate a patent was issued. In neither patent nor certificate were any monuments referred to, except the initial point. The east line of this tract corresponded with the west line of defendant's land, which line was recognized for many years as the true division line by the owners on either side, until a survey was made, in which were found what are claimed to be the original stakes set by certain government surveyors, which would carry the division line 3.88 chains east, and give plaintiff twenty-seven more acres than are called for by the government patent. The courses and distances given in the field-notes of this government survey corresponded with those given in the patent. *Held*, that the boundary line was as fixed by the certificate and patent.—Hale v. Cottle, (Or.) 28 P. 901.

14. Where a deed describes the lot conveyed as bounded by certain lines, beginning at a corner on a certain street, "thence northerly * * * 134 feet; * * * thence westerly * * * 60 feet; thence southerly, * * * at right angles" to the street of beginning, 125 feet; thence easterly on said street, 61 feet, more or less, to the first mentioned bound,

containing 7,770 feet, more or less,"—the third line must be drawn at right angles to the street mentioned, though this will make the fourth line 80.52 feet long, instead of 60.5 feet, and the whole lot will contain 9,101 square feet, instead of 7,770.—Hall v. Eaton, 29 N. E. 660, 139 Mass. 217.

15. A deed of unimproved land "estimated" as 200 acres, described the boundaries as "beginning at two birches on Simmons creek, corner to A's land; and running thence up said creek with M's line, S., 55° W., 120 poles, to six chestnuts, corner to M's survey; and with the same S., 35° E., 310 poles, to a double and single poplar, corner to A.; and with the same N. 40° E., 250 poles to the beginning." *Held*, it being apparent that in running the lines in the reverse direction all the calls would be satisfied, and the ambiguity would disappear, such course should be adopted, especially as such boundaries were natural, rather than a construction which would entirely ignore Simmons creek," "Miller's line," the course "S. 55° W." and the distance "120 poles," notwithstanding that the lines so run in the reverse direction would include 375 acres.—Simmons creek Coal Co. v. Doran 12 S. Ct. 239.

16. In a written obligation to convey certain real estate, it was described as N. ½ of S. E. ¼, of section 3, in a given township and range, "less twenty-five acres off the south side." *Held*, that *prima facie* the description manifested the intention to lay off twenty-five acres in a parallelogram, with the whole of the south line of the N. ½ of the quarter section in question as its base.—Watson v. Crutcher, (Ark.) 19 S. W. 98.

17. Certain lots conveyed were described by numbers according to the grantor's plat, and also as one piece of land, bounded by "the Philadelphia & Norriston Railroad," which appeared on the city plan of streets as a plotted street 120 feet wide, in the center of which was a railroad right of way 66 feet wide, with a strip 27 feet wide on each side thereof, intended by the city as a public street. The grantor, in making his plat, adopted the line of this street, and many of his lots including those conveyed fronted thereon. *Held*, that the grantee's title, as against the grantor, extended to the middle of the street, subject to the existing rights of the railroad, the city, and the owners of lots in the grantor's plat.—Dobson v. Hohenadel, (Pa. Sup.) 23 A. 1128.

18. The fee of the streets of the city of Richmond is in the abutting owners, subject to the lawful use of the streets by the city. Telegraph Co. v. Williams, 11 S. E. 106, 86 Va. 700, and Hodges v. Railroad Co., (Va.) 14 S. E. 380, followed.—Page v. Belvin, (Va.) 14 S. E. 843.

19. A deed is sufficient which describes the land as being on a particular stream in a designated parish, adjoining certain

named properties, or upon the stream upon which it is situated within the parish designated, with the number of acres it contains, referring to the conveyance by which the vendor acquired it; errors in the description by legal subdivisions being cured by other descriptive designations, which leave no doubt of the particular tract that was intended to be sold.—Bryan v. Wisner, (La.) So. 290.

20. A deed described the land conveyed as beginning at a certain rock, and running thence one mile east, one mile north, one mile west, and one mile south to place of beginning, and also stated that it was the land set off to a certain Indian under a treaty with the government. The Indian had previously selected his land as "a tract one mile square, the exact boundaries of which may be defined when the surveys are made." After the deed was given, the Indian's land was located and patented so as to include four distinct but adjacent parcels, no part of which lay within the boundaries named in the deed. *Held*, that the deed was not a float, but attached to the described lands, and in the absence of mistake could not be construed to pass title to any of the patented lands.—Duluth Storage and Forwarding Co. v. Prentice, (Cir. Ct.) 50 F. 878.

21 Act Cong. 1848, establishing the territorial government of Oregon, and providing (sections 1—6) that to every white male citizen of the United States, emigrating to, and settling in said territory between certain dates, are granted, if single, 160 acres of land, if he shall reside on and cultivate said land for the space of four years, is a grant, and, when the grantee has qualified himself by a four-years residence and cultivation to receive the title, it immediately vests in him, though he has made no final proof, such proof being simply evidence that the grantee is entitled to a patent.—Roeder v. Fouts, (Wash.) 31 P. 432.

22. Defendants' grantor bought a tract of land described as beginning 10 chains south of the N. E. corner of a certain quarter section, running thence south 5 chains and west 10 chains so as to include 5 acres. He then platted into lots 30 feet wide, the N. ½ of the S. E. ¼ of the N. E. ¼ of said quarter section. As the quarter section contained more than 160 acres, the north line of the platted land was three feet south of the deeded land. *Held*, that a purchaser of one of the northern tier of lots, whose deed simply called for the lot by number, and who had actual notice that there was a three-foot strip north of his lot, and who had possession of 30 feet without said strip, took no title to said three-foot strip.—Mendel v. Whiting, (Ill. Sup.) 31 N. E. 431.

23. In an action by the grantee in a deed running "to a point" in Long Island Sound, to recover for a deficiency in

the acerage of the land conveyed, on the ground that the deed could only convey to the high-water line of the shore, it will not be presumed, in the face of the description in the deed definitely calling for the low-water line as the boundary, that the grantor had no title to the shore, since the common-law rule that the title to the shore is in the state does not exclude the possibility of title in the grantor derived from the state or by prescription.—Oakes v. De Lancey, (Sup. N. Y.) 15 N. Y. S. 561, affirmed.—Oakes v. DeLancey, (N. Y. App.) 30 N. E. 974.

DRAINAGE.

1. Where the court acquired jurisdiction over the subject matter by the filing of the petition, and jurisdiction over the person of the land owners by giving the statutory notice, the fact that ten days did not intervene between the time the proceedings were docketed and the time at which the court referred the petition to the drainage commissioner, will not render such proceedings void.—McBride v. State, (Ind. Sup.) 30 N. E. 699.

2. The fact that the surface of the land at the mouth of a sewer is lower than at its beginning does not prove that the sewer carries the water according to its natural drainage, where it appears that the land between the two points is so elevated that the sewer had to be sunk nine feet in order to secure a proper fall.—Dierks v. Commissioners of highways Tp. Addison, (Ill. Sup.) 31 N. E. 496.

3. Laws 1883, p. 139, §8, which authorizes commissioners of highways to enter upon land adjacent to any highway, for the purpose of opening drains or ditches to carry off the water from the highway, or drain any slough or pond on such highway, does not authorize them to enter land adjacent to a highway for the purpose of carrying over such land the sewage deposited on such highways by the drains of an incorporated village.—Dierks v. Commissioners of Highways Tp. Addison, (Ill. Sup.) 31 N. E. 496.

4. The circuit court has jurisdiction of the construction of drains, and objections to its assumption thereof in a specific case must be made directly by appeal, and a party cannot, after judgment, make collateral objection to its authority to direct the construction of a particular drain, which it has assumed, by holding the petition sufficient to give the jurisdiction.—Perkins v. Haywood, (Ind. App.) 31 N. E. 670.

5. Pub. Acts 1885, c. 227, subc. 3, § 12, provides that in case a jury, impaneled to ascertain the compensation to be made for land taken for a public drain, shall decide such drain to be unnecessary, they shall so state in their return, and the drain commissioner shall thereupon dismiss the proceedings,

and no further application for the same object shall be entertained within one year thereafter. *Held*, that the statute does not apply where the jury are discharged by reason of their failure to agree, and in such case a new jury may be impaneled without waiting a year.—Morse, C. J., dissenting. Kress v. Jackson Probate Judge, (Mich.) 52 N. W. 728.

6. Elliot, Supp. § 1193, empowering a county surveyor to levy assessments to keep public ditches in "repair," does not empower him to construct new ditches.—Romack v. Hobbs, (Ind. Sup.) 32 N. E. 307.

7. The question as to what is the most available route for the location of a ditch is one for the judgment of the drainage commissioners, and their action in making such location is not subject to review on appeal, in the absence of fraud.—Chandler v. Beall, (Ind. Sup.) 32 N. E. 597.

8. Where surface water habitually flows off over a fixed and determininate course, having reasonable limits as to width, so as to be uniformly discharged at a definite point, though without having worn out a channel having definite and well-marked banks, the line of flow is a water course, within the meaning of Rev. St. 1891, c. 42, § 78, which declares that owners of land may drain the same "into any natural water course."—Lambert v. Alcorn, (Ill. Sup.) 33 N. E. 53.

9. Substituting an underground tile drain for natural surface drainage over the same land is not an abandonment of the natural water course.—Lambert v. Alcorn, (Ill. Sup.) 33 N. E. 53.

10. The owner of land adjoining a highway has no right to drain his land into a ditch in such highway by means of a drain which carries the water in a different direction from its natural flow.—Davis v. Commissioners of Highways, (Ill. Sup.) 33 N. E. 58.

11. Rev. St. 1891, c. 42, §117, declares that owners of land outside a drainage district, who connect their ditches with those of the district, shall be deemed to have applied to be included in the district. *Held*, that the owners of such lands having, by connecting with the district ditches, voluntarily consented to the inclusion of their land in the district, are not entitled to notice of the order of the commissioners' changing the boundaries of the district so as include their lands. Commissioners v. Griffin, 25 N. E. 995, 134 Ill. 330, distinguished.—People v. Dornblazer, (Ill. Sup.) 32 N. E. 688.

12. Rev. St. 1891, c. 42, § 117, declares that owners of land outside a drainage district, who connect their ditches with those of the district, shall be deemed to have applied to be included in the district, and that their lands benefitted thereby shall be treated, classified, and taxed as other lands in the dis-

trict. *Held*, that the fact that a drainage district lies wholly within one township, and the highway commissioners are ex officio the drainage commissioners, does not prevent them from taxing for drainage purposes land in another township, which has been by its owners connected with the drains of said district, since in levying such taxes the commissioners act as officers, not of the township, but of the drainage district.—People v. Dornblazer, (Ill. Sup.) 32 N. E. 688.

13. A ditch was opened on plaintiff's land in 1882 by the order of the supervisor. The statutes provided for an assessment of damages in such cases, to be made by three electors appointed by the supervisors, and from their award there was no appeal. Laws 1885, c. 46, amended the statute by allowing an appeal to the circuit court. Subsequent to the amendment appraisers were appointed, who found that plaintiffs were not damaged by opening the ditch. *Held*, that plaintiffs were entitled to appeal from the award, since the act of 1885 was remedial, and did not interfere with vested rights.—Smeaton v. Austin, (Wis.) 51 N. W. 1090.

14. Where a railroad company constructs a ditch along its right of way, whereby it diverts surface water from the direction in which it naturally flows, and overflows land on the natural water course into which the water so diverted is finally emptied, the company is liable for the damage, though the ditch was necessary to the operation of the road and it was carefully constructed. Jenkins v. Railroad Co., 15 S. E. 193, 110 N. C. 438, followed.—Staton v. Norfolk & C. R. Co., (N. C.) 16 S. E. 181.

15. The question of the practicability of a route to be selected for a public ditch is in the discretion of the inferior tribunal or its officers, and cannot be reviewed on appeal.—Sample v. Carroll. (Ind. Sup.) 32 N. E. 220.

16. The selection of the line of a former ditch is not an abuse of such discretion.—Sample v. Carrol, (Ind. Sup.) 32 N. E. 220.

17. Since drains constructed under Act March 9, 1875, were not especially constructed under the supervision of the commissioners charged with their establishment, the county surveyor was not obliged to wait until such drains were entirely completed before having them repaired, as commanded by Elliott's Supp. 1889, § 1193, but might take possession, for that purpose, of the completed portions.—Artman v. Wynkoop, (Ind. Sup.) 31 N. E. 468.

18. Where a county commissioner, in determining the necessity for taking certain land for a drain, neglects to specify the size and location of the drain, as required by statute, or in case a jury is demanded, to issue a *venire* describing the

land, the proceedings are so defective that no legal drain can be laid, and a township supervisor, therefore, may lawfully refuse to assess a tax.—Nugent v. Erb, (Mich.) 51 N. W. 282.

19. Where a drain commissioner made his apportionment of benefits for a drain, and assessed twenty-seven per cent. of the cost on three forties of land as belonging to T., and thereafter, on learning that J. owned one of the forties, made out his assessment roll for the supervisors, dividing such cost in proportion to the acreage, and placing one-third of the amount on J.'s forty, it was an irregularity which justified the supervisors in refusing to spread the tax on such forty. —Tinsman v. Board of Supervisors, Monroe County, (Mich.) 51, N. W. 460.

20. The fact that a land-owner appeared before the commissioners appointed to assess damages and benefits for a drain, and accepted the award of damages to part of his lands, and entered into a contract to construct the drain through such lands, did not estop him from objecting to an irregularity in assessing another parcel, where he had no knowledge that such other parcel had been assessed until the assessment roll was completed, at which time it was too late to appeal from the act of the commissioners.—Tinsman v. Board Supervisors, Monroe County, (Mich.) 51 N. W. 460.

21. Though laws of Indiana provide that ditch assessments shall be made by the county surveyor, and appeals therefrom prosecuted against him, the county only is financially interested in the collection of the assessment, and is entitled to defend in the name of the county surveyor, or to employ attorneys to appear for the county surveyor and resist the appeal.—Stingley v. Nichols, Shepherd & Co., (Ind. Sup.) 30 N. E. 34.

22. A county surveyor cleaned out a public ditch and its arm, and warrants were drawn on the county treasurer to pay therefor. An assessment was afterwards made on the land-owners along the ditch to reimburse the county, from which assessment they appealed. The appeal-bonds were made payable to the county surveyor, instead of the deputy-surveyor, who made the assessment. The lands assessed were not described therein, nor was it stated whether the repairs were to the main ditch or its arm. *Held* immaterial.—Stingley v. Nichols, Shepherd & Co., (Ind. Sup.) 30 N. E. 34.

23. Upon proceedings to assess benefits of a proposed extension of a ditch, the fact that certain lands in the drainage district are sufficiently drained by the ditch without an extension is no objection to assessing such lands on account of the extension.—Briggs v. Union Drainage District, (Ill. Sup.) 29 N. E. 721.

24. Land not assessed for the construction of a ditch cannot be assessed for repairs, under the express provisions of Elliott Supp. § 1193.—Scott v. Stingley, (Ind. Sup.) 31 N. E. 953.

25. On appeal to the circuit court from assessments levied by the county surveyor for the repair of a ditch, appellants cannot escape liability on the ground that no additional assessments had been levied against other land-owners, who had permitted the cattle to obstruct the ditch, where appellants made no effort to prove the additional cost of removing such obstruction so as to enable the court to adjust the assessments.—Scott v. Stingley, (Ind. Sup.) 31 N. E. 953.

Under Elliott Supp. §1193, which requires the county surveyor to keep the ditches in his county in repair, the surveyor is the judge of the means to be employed to accomplish the work, and land-owners cannot escape liability on assessments because the workmen employed were paid by the day, and no competition was invited.—Scott v. Stingley, (Ind. Sup.) 31 N. E. 953.

27. The fact that a county surveyor, in repairing a ditch, exceeded the jurisdiction conferred on him by Elliott, Supp. § 1193, in that he widened the bottom of the ditch beyond the original specifications, does not relieve the land-owners from paying for benefits received by the performance of such work as was within the jurisdiction of the surveyor; and where the assessments levied are short of the amount actually paid by the county for the repairs, the supreme court on appeal will presume, in the absence of evidence to the contrary, and in favor of the findings of the lower court sustaining the assessments, that appellants' lands were not assessed in an amount greater than their just proportion of legitimate costs of repairing the ditch.—Scott v. Stingley, (Ind. Sup.) 31 N. E. 953.

HIGHWAYS.

1. Where it is necessary for a commissioner of highways, in the discharge of his public duty, to shut off the water from a mill in order to repair a culvert forming part of an artificial water course or tailrace, passing under a public street, and the repairs are prosecuted with diligence and reasonable care, the commissioner is not liable for damages for the loss of power to the mill pending such repairs.—Kerr v. Joslin, (Sup.) 20 N. Y. S. 929.

2. A highway which, after having been opened and used beyond the memory of any living man, is found not to conform precisely to the original survey, can only be changed by proceedings under the road laws; and until such proceedings are had the abutting owners cannot be compelled to conform

to the survey, or to remove improvements not within the highway as theretofore existing.—Hancock v. Borough of Wyoming, (Pa. Sup.) 24 A. 88.

3. The fact that a strip of land conveyed to a city for highway purposes, while extending from a public street, terminates on private land, and does not connect with any other street or public place, does not take it out of the operation of Pub. St. c. 64, §25, relating to conveyances for highway purposes, since a cul de sac may be a highway. Simmons v. Mumford, 2 R. I. 172, 184, distinguished and doubted.—Greene v. O'Connor, (R. I.) 25 A. 692.

4. Where a town has been laid out, and one of the streets, as originally marked, used by the public for forty-five years, mere nonuser of a portion of such street, occasioned by being fenced in with abutting property, for forty years, will not constitute an abandonment by the public.—Wolfe v. Town of Sullivan, (Ind. Sup.) 32 N. E. 1017.

MUNICIPAL CORPORATIONS.

1. Const. art. 16, § 8, declaring that "municipal and other corporations invested with the privilege of taking property for public use shall make just compensation for property taken or destroyed by the construction or enlargement of their works or improvements," does not give the owner of private property a right of action against a city for injury caused his property by the construction of a sewer inadequate to carry off the water, whereby the water is banked up and backed upon his property, where the construction of the insufficient sewer is due to a mistake of judgment on the part of the city authorities, and not to an improper construction of the sewer.—Bear v. City of Allentown, (Pa. Sup.) 23 A. 1062.

2. Where a city, under legislative authority, constructs, in the bed of a stream, a covered sewer, which in ordinary storms is sufficient to carry off the water, it will not be liable, if by reason of an extraordinary storm, the sewer becomes clogged, and causes the water to overflow,and injure adjoining property. Fair v. City of Philadelphia, 88 Pa. St., 309, and Collins v. City of Philadelphia, 93 Pa. St. 272, followed.—Fairlawn Coal Co. v. City of Scranton, (Pa. Sup.) 23 A. 1069.

3. Where the necessary effect of digging a ditch is to throw water from the public street upon the land of a private person, the municipality that digs the ditch is not relieved of liability for damage done by such water by the fact that the ditch was dug upon the land of a third person with that person's consent.—Wier v. Borough of Plymouth, (Pa. Sup.) 24 A. 94.

4. It is proper to refuse to instruct the jury that, in the absence of clear proof that water running from the street upon

plaintiff's lot was the sole cause of the injury, plaintiffs are not entitled to recover.—Weir v. Borough of Plymouth, (Pa. Sup.) 24 A. 94.

5. Act May 16, 1891, (P. L. 75,) § 8, providing for the appointment of viewers to assess the cost of street improvements in cities "on the property benefitted, according to benefits, if sufficient can be found, but if not," that "the deficiency, when finally ascertained, shall be paid by the municipal corporation," does not deprive the city of the general power to make such improvements at the expense of the city, and the council of a city may set apart, out of the general revenue, sufficient money to pay for the construction of a sewer.—Commonwealth v. George, (Pa. Sup.) 24 A. 59; Id. 61.

6. The committee of the common council of the city of Richmond on streets undertook to change the grade of a street without the authority of the common council. *Held*, that the council had no power to validate the acts of the committee, in the premises, by subsequent ordinance.—Page v. Belvin, (Va.) 14 S. E. 843.

7. The recorded resolution of the committee on streets, their report to the common council, and a resolution of the council founded thereon, referred only to the relaying of gutters in the street in question. *Held*, in an action in trespass for changing the grade, that the testimony of the members of the council was improperly admitted to show that the council in fact ordered the grade of the street to be changed.—Page v. Belvin, (Va.) 14 S. E. 843.

8. Under Const. art. 16, § 8, which declares that municipal corporations "shall make just compensation for property taken, injured, or destroyed by the construction or enlargement of their works, highways, or improvements," plaintiff, who has built a house on his lot in conformity with the existing physical grade of an old public highway in front of the lot, may recover from the city damage to the lot resulting from a change in the grade.—O'Brien v. City of Philadelphia, (Pa. Sup.) 24 A. 1047.

9. Where a city changes the grade of the street, it is not liable to an abutting lot owner for damages resulting therefrom to a house erected on the lot after the change in grade was authorized.—Groff v. City of Philadelphia, Pa. (Sup.) 24 A. 1048.

10. Where a street was laid out on the official plans of the city when plaintiff purchased an abutting lot, and was thereafter dedicated for highway purposes by a proper deed, and subsequently thereto was opened and graded by the city, the city is liable to plaintiff for any damages occasioned thereby. —Hobson v. City of Philadelphia, (Pa. Sup.) 24 A. 1048.

11. Rev. St. 1891, c. 24, art. 9, § 1, authorizes cities and villages to make "local improvements by special assessment, or by special taxation, or both, of contiguous property, or by general taxation, or otherwise, as they shall by ordinance prescribe." Section 2 requires the ordinance providing for such an improvement to "prescribe whether the same shall be made by special assessment, or by special taxation of contiguous property, or general taxation, or both. *Held*, that a city could not combine general taxation, special taxation, and special assessment in making a single improvement.—Kuehner v. City of Freeport, (Ill. Sup.) 32 N. E. 372.

12. Laws 1867, c. 479, (Dunkirk Village Charter,) tit. 12, provided that the village trustees should publish a resolution of its intention to construct a sewer, and give an opportunity for the hearing of objections before ordering the sewer to be built. Title 13 authorized the trustees to order the paving or grading of a street, and caused the expense to be assessed, but required no adoption or publication of intention to pave or grade the street. Laws 1880, c, 19, changed the village into a city, and amended the charter of 1867. Title 12 of the charter as amended consolidated the provisions for constructing sewers with those for grading and paving streets, and provides that, whenever the common council of the city may deem it necessary to construct a sewer or to grade or pave a street, it may declare by resolution its intention to do so, and order the work to be done; but it does not provide for publishing the resolution or for hearing objections. *Held*, that the provisions of the village charter of 1867 as to publication and opportunity to object, if in force at all under the repealing clause of the city charter of 1880, is only in respect to constructing sewers, and does not apply to paving streets.—Lake Shore & M. S. R. Co. v. City of Dunkirk, (Sup.) 20 N. Y. S. 596; New York, L. E. & W. R. Co. v. Same, Id.

13. The charter of Duluth provides that the board of public works shall, subject to the approval of the common council, establish a system of grades for all streets, avenues, and alleys within the corporate limits for which grades have not been heretofore established, and that, to change a grade once established, there must be a resolution of the council, passed by a vote of two-thirds of the members-elect. *Held*, that it was the intention of the legislature to require the permanent grade to be established before any proceedings for the permanent improvement of a street at the expense of the real property should be commenced.—State v. Judges of District Court of Eleventh Judicial District, (Minn.) 53 N. W. 800.

14. An agreement was made by a city with a railway company not to oppose before the railroad commissioners certain

changes which the company desired to make on its line through the city, by which it would partly cut off travel on several streets, the consideration being that the company would pay the property owners on such streets whatever damage their property suffered. The contract was entered into at the request of the owners of the property for their benefit and protection. *Held*, that the contract was against public policy, and void, since it was made by public officials in consideration of private benefit to certain individuals, and no provision was made by which the public was recompensed for its loss of the right of travel through the street.—City of New Haven v. New Haven & D. R. Co., (Conn.) 25 A. 316.

15. A village, being responsible for injuries caused by defects in its streets, and being charged by law with the duty of keeping them in repair, may maintain an action to prevent them from being torn up or excavated.—Waukesha Hygeia Mineral Spring Co. v. Village of Waukesha (Wis.) 53 N. W. 675.

16. Under a village charter giving control over the public streets, and power to pass any ordinance "usual or necessary for the well-being of the inhabitants," the village may limit the time trains may block a street crossing.—Burger v. Missouri Pac. R. Co., (Mo. Sup.) 20 S. W. 439.

17. The location of a sewer in a city street must be reasonable, with respect to the rights of a street railway, the construction of which was authorized by a prior ordinance, and whose property might be damaged by such sewer; and such location, if made in a part of the street occupied by the railway, so as to compel it to suspend operations, and inflict great damage upon it, is unreasonable, when other parts of the street are equally suitable for the sewer.—Clapp v. City of Spokane, (C. C.) 53 F. 515.

RAILROADS.

1. In an action to recover damages for an overflow, caused, as alleged, by the construction of an embankment across one branch of a water course, an instruction that no recovery can be had if the jury "find from the evidence that the damage complained of was due to an overflow, caused by an extraordinary rainfall or flood," is misleading and properly refused. —Ohio & M. Ry. Co. v. Webb, (Ill. Sup.) 32 N. E. 527.

2. In an action against a railroad company for damages resulting from the construction of a solid embankment so as to obstruct the natural flow of a stream, an instruction that "it is the duty of a railroad company to construct and maintain its road across streams and natural water courses which it intersects so as to inflict no injury upon adjacent lands," is not too

broad, as stating it to be the duty of the railroad company to inflict no injury whatever, when it is made plain by other instructions, and the allegations and proofs in the case, that it was sought to hold the defendent liable only for injury which might have been avoided by the proper construction of an embankment with culverts.—Ohio & M. Ry. Co. v. Thillman, (Ill. Sup.) 32 N. E. 529.

3. In an action against a railroad company for damages resulting from the construction of a solid embankment so as to obstruct the natural flow of a stream, it is not error to instruct the jury that it is the duty of a railroad company to construct and maintain its road across streams so as to inflict no injury on adjacent lands, and that "this duty is a continuing one, and each overflow caused by the negligence or want of skill of the company creates a new cause for damages to the crops or other property of the rightful possessor of the lands overflowed."—Ohio & M. Ry. Co. v. Thillman, (Ill. Sup.) 32 N. E. 529.

4. Where, in the construction of a railroad, a stream is turned from its natural course, and made to pass under the track in the channel of another stream, merely for the purpose of diminishing expense, the company will be liable in damages for overflow caused thereby above the point of original intersection of the streams, as well below as above the track, though the water-way under the track furnished ample room for the passage of the water in time of freshet.—Adams v. Durham & N. R. Co., (N. C.) 14 S. E. 857.

5. Where a railway company builds its road through a fenced pasture, and fails to erect and maintain cattle guards at the entrance and exit of its road to and from the pasture, as required by statute, the owner may recover damages for the loss of the pasture, or, if he put his animals therein, to reasonable compensation for his efforts in preventing them from straying from the pasture, and injuring the crops on his own premises, or from trespassing on the lands of other persons. Railway Co. v. Behney, 28 P. 980, 48 Kan.—followed.—Nelson v. St. Louis & S. F. Ry. Co., (Kan.) 30 P. 178.

RIPARIAN RIGHTS.

1. Where the mainland on both sides of a stream and an island dividing the stream have been surveyed and sold by the government as separate parcels, the *filum aquae* is established in the center of the channels on both sides of the Island, between it and the mainland, as though two distinct streams existed; and where the owner of the island also owns the mainland on one side of the stream, for hydraulic purposes he is entitled to the use of the entire natural flow of water in the

channel on the side of the island on which he owns the mainland, and one-half of the flow on the opposite channel.—West v. Fox River Paper Co., (Wis.) 52 N. W. 803.

2. The title to land over which the tide ebbs and flows is in the state, and a conveyance thereof vests the absolute title in the grantee.—Bowlby v. Shively, (Or.) 30 P. 154; Hogg v. Davis, Id. 160.

3. Where a meandered lake is "non-navigable," in fact, the patentee of the riparian land takes the fee to the center of the lake; but, if the lake is "navigable" in fact, its waters and bed belong to the state in its sovereign capacity, and the riparian patentee takes the fee only to the water line, but with all the rights incident to riparian ownership on navigable waters, including the right to accretions or relictions formed in front of his land by the action or recession of the water.—Lamprey v. Metcalf, (Minn.) 53 N. W. 1139.

4. When the United States has disposed of the lands bordering on a meandered lake, by patent, without reservation or restriction, it has nothing left to convey, and any patent thereafter issued for land forming the bed, or former bed of the lake, is void and inoperative.—Lamprey v. Metcalf, (Minn.) 53 N. W. 1139.

5. Where the United States has made grants without reservation or restriction of public lands bounded on streams or other waters, the question whether the lands forming the beds of the waters belong to the state, or to the owners of the riparian lands, is to be determined entirely by the law of the state in which the lands lie.—Lamprey v. Metcalf, (Minn.) 53 N. W. 1139.

6. The owner of a city lot bounded on one side by a street which is located along a river, is not entitled, as a riparian proprietor, to land formed by accretions on the opposite side of the street.—Lebeaume v. Poctlington, 21 Mo. 36, and Smith v. Public Schools, 30 Mo. 294 followed.—Ellinger v. Missouri Pac. Ry. Co., (Mo. Sup.) 20 S. W. 800.

7. A vender who sells the entire estate owned by him up to the line of a public road bordering a river, and beyond which no property susceptible of private ownership exists at date of sale, retains no estate to which the accessory right to future alluvion can attach; and since the purchaser must bear the loss in case of any encroachment by the river, he is entitled to the alluvion on the equitable principle that "qui sentit onus, sentire debet et commodum."—Succession of Delachaise v. Maginnis, (La.) 11 So. 715.

8. The intervention of a public road between an estate and the river, does not prevent the owner of the estate from being considered as the front or riparian proprietor, when

nothing susceptible of private ownership exists between the road and the river.—Succession of Delachaise v. Maginnis,(La.) 11 So. 715.

9. Where the owner of "Rice's Point," on Duluth bay, platted it into blocks and streets, some of the blocks being entirely out in the water, beyond, and in front of the shore block, he indicated his intention to separate the shore block from the submerged blocks, and a deed of the former, according to the plat, conveys no interest in the latter.—Gilbert v. Eldrige, 59, N. W. 679, 47 Minn. 210, followed.—Bradshaw v. Duluth Imperial Mill Co., (Minn.) 53 N. W. 1066.

10. The right of the riparian proprietor on navigable waters to reclaim and occupy the submerged lands out to the point of navigability may be separated from the shore land, and transferred to one having no interest in the parent riparian estate.—Bradshaw v. Duluth Imperial Mill Co., (Minn.) 53 N. W. 1066.

11. The fee in the streets, alleys, commons, and public grounds, as exhibited on the maps of the subdivision of fractional sections ten and fifteen, lying on the lake front of Chicago, is vested in the city, together with the riparian rights appertaining thereto; and these rights were not divested by the fact that the Illinois Central Railroad occupied the lands underlying the immediate front, and filled them in for its right of way, under authority of a city ordinance; and the city still has the right to exercise such riparian rights, subject to the terms of the ordinance and to the authority of the state to prescribe the lines beyond which no structures may be extended, and also subject to such supervision and control as the United States may lawfully exercise. 33 F. 730 affirmed.—Illinois Cent. R. Co. v. State, 13 S. Ct. 110; City of Chicago v. Illinois Cent. R. Co., Id.; State v. Illinois Cent. R. Co., Id.

12. An island in a lake, proved to have existed as such prior to the survey of 1851, though not then platted, and by process of accretion since become joined by a spit to a neighboring lot, is not a portion of that lot.—Bigelow v. Hoover, (Iowa,) 52 N. W. 124.

13. Alluvion deposited against an island in a lake and a neighboring lot, so as to connect them, must be equally divided between the owners of both.—Bigelow v. Hoover, (Iowa,) 52 N. W. 124.

14. Long Pond, in Concord, whose bed, in its natural condition contains about 160 acres, being navigable within the meaning of the American common law, is the property of the state for the use of the public.—Concord Manuf'g Co. v. Robertson, (N. H.) 25 A. 718.

15. Where the owner of land abutting on Lake Superior

plats it, together with the shallows beyond the shore, the establishment of a dock line inside of some of the submerged blocks, does not divest any property rights therein, but merely regulates and limits their use; so that while the dock line remains in force, the owner cannot use the property for any purpose inconsistent with the public right of navigation; but the change of location of dock line to a point outside of the lots removes this limitation, and amounts to authority from the state to fill in and build out to the new line—Bradshaw v. Duluth Imperial Mill Co., (Minn.) 53 N. W. 1066.

16. The reclamation of the Illinois Central Railroad Co. from the waters of Lake Michigan of a tract 200 feet wide, extending along the front of the city of Chicago, and the construction of its tracks, crossings, guards, etc., and the erection of the breakwater on the east thereof, and the necessary works for the protection of the shore on the west, all as required by the ordinance under which it was permitted to enter the city, did not interfere with any useful freedom in the use of the waters of the lake, for commerce—foreign, interstate, or domestic,—or constitute such an encroachment upon the domain of the state as to require the interposition of a court for their removal, or for any restraint in their use. 33 F. 730 affirmed.—Illinois Cent. R. Co. v. State, 13 S. Ct. 110; City of Chicago v. Illinois Cent. R. Co., Id.; State v. Illinois Cent. R. Co., Id.

17. The railroad company did not, however, acquire by such reclamation, an absolute fee in the lands reclaimed, or any right of use, disposal or control, except for a right of way, and for railroad purposes; nor did it thereby acquire any rights as a riparian owner, to reclaim still further lands from the lake for its use, or for the construction of piers, docks and wharves, in furtherance of its business.—Illinois Cent. R. Co. v. State. 13 S. Ct. 110; City of Chicago v. Illinois Cent. R. Co., Id.; State v. Illinois Cent. R. Co., Id.

18. In respect to the lots lying north of Randolph street, in said city, and the lots in front of Michigan avenue, all bordering on the lake, and to which the company acquired the fee by purchase, it was vested with riparian rights, and thereby became entitled to fill up the shallow waters of the lake, and to construct piers, wharves, docks and slips not extending beyond the point of navigability. 33 F. 730, affirmed.—Illinois Cent. R. Co. v. State, 13 S. Ct. 110; City of Chicago v. Illinois Cent. R. Co., Id.; State v. Illinois Cent. R. Co., Id.

19. The Hudson River Railroad cannot, by virtue merely of the construction of its railroad under charter along the east side of the Hudson river, on land partly below high water, conveyed to it for that purpose by owners of the adjacent uplands, be regarded as an adjacent owner, within Laws 1850, c. 283,

allowing a grant of land under water only to such an owner; and neither can it be allowed to defeat a grant to a private person under said charter of land next under the water to its own, and which does not interfere with its operation, by extending its tracks thereover pending application for the grant under supposed authority conferred by charter to alter its location at any time; and particularly can this not be allowed, as the mere enlargement of its location as proposed is not an alteration within meaning of the charter. 16 N. Y. S. 674, affirmed.—New York Cent. & H. R. R. Co. v. Aldridge, (N. Y. App.) 32 N. E. 50; Saunders v. New York Cent. & H. R. R. Co., Id. 54.

20. The conveyance of land for a railroad right of way, partly above and partly below high water, along the bank of a river, by one owning the adjacent uplands, does not destroy the grantor's character as riparian owner, so that a patent may not issue to him under Laws 1850, c. 283, as to the owner of adjacent land, for the land lying next under the water.—New York Cent. & H. R. R. Co. v. Aldridge, (N. Y. App.) 32 N. E. 50; Saunders v. New York Cent. and H. R. R. Co., Id. 54.

21. Where one, without right, enters on, and fills up land under navigable water, thereby raising it above the water, he acquires no title to such land, and is not an adjacent owner, within the statute—People v. Commissioners of Land Office, (N. Y. App.) 32 N. E. 139.

BUSINESS TRANSACTIONS.

The business meeting of the convention was held on Thursday morning, January 19.

The report of the Secretary was read as follows:

SECRETARY'S REPORT.

Since the reports published in our last Annual the following business has been transacted for the Society:

The annual meeting of the board of directors was held at the Hudson House in Lansing, October 12, 1892. There were present Secretary Hodgman, Director Steele, and members Appleton, Skeels and Sellers.

The members of the board present assumed the right to canvass the votes for officers, and the following were declared elected for the ensuing year: President, E. W. Muenscher; Vice-President, Geo. S. Pierson; Secretary-Treasurer, F. Hodgman; Directors, Wm. Appleton, Dorr Skeels and J. B. Davis.

Messrs. Appleton and Skeels filed their acceptance of the offices to which they had been elected.

The annual report of the Secretary was read and approved.

The annual report of the Treasurer was read and approved.

The memberships of the following persons were declared annulled, for two years' non-payment of dues, as provided by by-law No. 6, viz: James Wiseman, O. S. Heyden, J. Kvam, T. W. Pettee, H. L. Chapin, A. Childs, E. C. Martin, and Willis Baldwin. Communications were read from other delinquent members and action in their cases deferred.

It was voted to hold the next annual meeting in Lansing, in the third week in January, 1893. The Secretary was directed to invite certain members of the Society to prepare papers for the convention, and it was determined to make the road question the leading topic of discussion and to set apart the second day of the convention for that purpose.

The further arrangements for the convention were left to the President, Secretary, and members living in Lansing.

The bill of Geo. E. Steele for $14.85 for expenses attending the meeting of the board of directors, was audited and allowed.

The board then adjourned.

The following are the reports submitted to the board of directors:

SECRETARY'S REPORT TO DIRECTORS.

GENTLEMEN: I would report the following business transacted by me for the Society since the annual convention at Grand Rapids:

Immediately after the convention the job of printing the Annual was let to the lowest bidders, R. Smith & Co., of Lansing, and the copy prepared for them as fast as possible. There was some delay in getting advertisements, but the Annual was out before July 1, and distributed to all of our members not in arrears for dues. Exchange copies were sent to our sister societies in Ohio, Indiana, Illinois, Iowa, to the Provincial Land Surveyors in Canada, and to the engineering societies of the universities at Ann Arbor and Champaign. Return copies of reports have recently been received from all these societies except Ohio and the Provincial Land Surveyors. The Dominion Land Surveyors do not publish any reports this year.

I had 1,500 copies of our Annual published, and we now have on hand enough copies for several other exchanges if they could be secured.

On the first Monday in March I sent out letter ballots for officers and new members to all our members who were entitled to vote, and statements of account to all who were in arrears. I regret to say that but a small per cent. of the members have cast their ballots. On the first Monday in April the ballots for members were opened and canvassed by me and all the applicants found to be elected. On the first day of July I again sent statements to all who were in arrears for dues. On the first Monday in March I mailed to every member who was two years or more in arrears for dues a copy of the by-law No. 6, and the notice required by the by-law. The following members to whom such notices were mailed to their last known address, are still in arrears: J. J. Watkins, James Wiseman, O.

S. Heyden, J. Kvam, T. W. Pettee, H. C. Thompson, H. L. Chapin, E. F. Guild, G. A. Mark, C. B. Hyde, A. Childs, I. Teller, R. B. Merritt (deceased), E. C. Martin, and Willis Baldwin. I hand you herewith letters from some of these parties bearing on the subject. I have received notices of the deaths of John M. Clark and John O. Palmer, and saw an item in a Detroit paper referring to the death of R. B. Merritt, but have not been notified of it by his family.

F. HODGMAN,
Secretary.

TREASURER'S REPORT.

I would respectfully report the following sums as having been received and disbursed by me during the year ending October 12, 1892.

RECEIPTS.

On hand Oct. 14, 1891	$148 01	
Received from annual dues	253 00	
Received from advertisers	260 60	
Received membership fees	47 00	
Received from reports sold	17 50	
Total		$726 11

EXPENDITURES.

Expenses of Board of Directors	$ 11 25	
Express, freight, and drayage	29 07	
Miscellaneous printing	12 83	
Postage and envelopes	56 34	
Cuts and inset for Annuals	58 26	
Printing Annuals	261 37	
Collection fees	1 75	
American Digest	10 00	
Copyright	1 00	
Stenographer	54 00	
Telegraphing	1 12	
Secretary's salary, 1891	100 00	
Balance on hand Oct. 12, 1892	129 12	
Total		$726 11

The society owes nobody a cent.

There is due it from 19 members one year's dues each	$ 38 00
There is due it from 4 members two years dues each..	16 00
There is due it from 6 members three years dues each.	36 00
There is due it from 4 members four years dues each..	32 00
There is due it from advertisers.....	51 00
	$173 00

F. HODGMAN, Treasurer.

Subscribed and sworn to before me this 12th day of October, 1892.

GEORGE E. STEELE,
Notary Public.

The foregoing reports were accepted by the convention.

The following persons were nominated for officers for the next year: For President, E. W. Muenscher; for Vice-President, Geo. S. Pierson; for Secretary-Treasurer, F. Hodgman; for Directors, J. J. Granville, Dorr Skeels, J. B. Davis, James L. Rumsey, A. J. Teed, John McLoughlin and Ernest Sellers.

The reports of the Committee on State Boundary was read and adopted, and the committee directed to prepare and present a memorial to the Legislature. For report and memorial see page 77.

The report of the Committee on Road Legislation was received, discussed, amended and adopted. For report and memorial, see page 181.

Mr. Rogers extended an invitation for the next convention to be held in Port Huron. Mr. Granville gave a similar invitation for Saginaw, Mr. Teed for Cadillac and Mr. Skeels for Grand Rapids.

The Secretary called attention to the fact, that during the past year he had sent out statements three times at intervals of three months to every member in arrears for dues, and after that had drawn through the bank on those still in arrears. Some had paid when drawn on, some paid no attention to statements or draft, and one member considered it an outrage to be drawn on and had withdrawn from the society in consequence. He desired an expression from the society as to the propriety of drawing on members for their dues.

It was voted that the Secretary be directed to draw on

members for their dues when they do not respond otherwise.

It was voted to reprint 500 copies of the first two reports of the society at an expense not to exceed $60.00.

A committee consisting of Geo. L. Wells, Geo. M. Ames, John J. Granville, Henry F. Bean, and John McLoughlin was appointed to solicit advertisements for the Annual.

NOTE.—The Secretary here desires to acknowledge the assistance he has received from Charles Holmes, F. F. Rogers, D. J. Albertson and H. G. Rothwell in procuring advertising for the Annual. It has been of the greatest value and we should have been closely pinched to meet the extra expenses of 1893 without it.

A committee consisting of J. J. Granville, Wm. B. Sears and Seth Dean was appointed to prepare specifications for common roads, and it was voted that the Secretary send out advance copies of the same, previous to the next convention for the consideration and criticism of the members.

The following discussion was had relative to the preparation of papers for our annual convention.

THE PRESIDENT: I think it would be well to have a circular printed and send it around to city engineers and all others whose address can be obtained, soliciting them personally. And if any member of the Society has any subject in which he is interested, to have it suggested, so that others could be requested to write papers on that subject. Now for myself, I find very interesting this street railroad system, which is being very rapidly extended throughout the state. All our citizens are interested in it, and some of our roads are beginning to adopt a form of rail which I think is going to be very dangerous. I should like to have some one familiar with that subject, take it up in a paper—the form of street rails. I am inclined to think that the "T" rail now introduced is very dangerous, and that every city that introduces it, will rue the day. I may be mistaken, but would like to learn the experience of different cities on that point. I requested Mr. McLoughlin to write a paper on that subject, but he was unable to do so. Another thing that would interest me would be a paper on the different kinds of motive power used by street railways. I refer to the cable, electricity, and any other motive power in use. I know that some of our members are as competent as any men in the world, and they could furnish

such a paper as that if they would. I think there are very few of us that could listen to such a paper without learning something; I doubt if there are five members that could explain the operation of the trolley system.

MR. APPLETON: I know there is a man here who if he could be induced to do it, could tell us a great deal about it.

THE PRESIDENT: I should like such a member to gather what he can on this subject, and when we meet again, tell us what the progress has been in electric motors during the past year; it is something that is going to be fresh every year, and yet we come here and neglect these fresh, interesting subjects entirely.

MR. HODGMAN: One of the great difficulties with which the officers of this Society have had to contend in preparing for the convention, was in getting some one to suggest topics, and in getting suitable persons to discuss them. I have sometimes been afraid we should fail entirely on account of the lack of responses. So many have their hands full, and yet some of our best contributors are our hardest worked men. Prof. Davis said, "Don't you know, Hodgman, that if you want to call on some one to do a thing, you must call on some one who has his hands full already." A good many of our very ablest members have never lifted their hands to do anything.

MR. GRANVILLE: The trouble is, a good many of the new members are young men, and are too modest.

MR. HODGMAN: I have urged our young members to prepare things because it is for their own benefit. Nothing will help a young man so much as to take a subject, study it up and write a paper on it. Even if the paper he produces doesn't go to the bottom of the thing at all, it may bring on a discussion and bring out some very valuable thoughts.

MR. APPLETON: In looking over the Society this year, I think while there have been many excellent papers, on a great many subjects, there is a remarkable absence of mechanical engineering. Prof. Cooley has not been here,—Durand has gone from the College, and we seem to have no real live worker in that particular branch. I think this Annual will be very barren. Nothing in the field of electricity—no new

machinery—nothing of that kind ready to go into this Annual, and while we have some excellent things, there is an absence of some other things of a good deal of interest. Mechanical engineering is in its infancy, and is growing more and more interesting.

MR. RANDALL: I would like to second Mr. Appleton's remarks. I think no engineer can do his duty without knowing something of mechanical engineering. Our work is so closely connected with mechanical engineering that it will not hurt us to get some of these treatises on different branches of mechanical engineering.

THE PRESIDENT: I should like very much at our next meeting to have some of our members who are particularly interested in hydraulic engineering give us the results of recent progress in the construction of pumping engines. There has been a wonderful advance in pumping machinery in the last few years.

MR. BEAN: And how few are aware where the latest improvements are.

THE PRESIDENT: I shouldn't be surprised if the Society would be very glad to have Mr. Pierson give us something on this subject.

MR. APPLETON: Very few of you are acquainted with Mr. Jarvis, but he is probably as well posted on the subject of motive power for street railways as any man living, an inventor who has perfected a good many schemes, and I would move it as the sense of this entire meeting, that Mr. Jarvis be requested to prepare for us a paper on the different kinds of motive power used on street railways. I am sure he is capable of giving us a most interesting paper.

Motion supported and carried.

The Secretary was voted $100 for his services during the past year, and a vote of thanks extended to him.

A vote was taken expressing the sympathy of the Society with Mr. Forster in his illness, thanking him for his autobiography, and directing that it be given the place of honor in the forthcoming Annual.

The thanks of the Society were also extended to the President for his earnest work in the convention, to Mr. Sellers for

providing for the local wants of the Society, and to Mayor Bement for the courtesies extended by him.

The convention then adjourned.

MEETING OF BOARD OF DIRECTORS.

A meeting of the board of directors was held during the convention, and applications for membership received and passed upon. Other applications were received by the Secretary and submitted by letter to the board previous to March 1, 1893.

The following persons have been approved for membership by the Board of Directors and elected by letter ballot as members of the Society:

FOR SENIOR MEMBERS.

L. P. Breckenridge, Professor of Mechanical Engineering, Agricultural College, Lansing, Mich.

E. F. Bradt, Mining Engineer and Chemist, Ishpeming, Mich.

B. F. LaRue, Consulting Bridge Engineer, Jackson, Mich.

A. L. Marhoff, City Engineer, Battle Creek, Mich.

E. W. Redman, Civil Engineer, Grand Rapids, Mich.

Ernest Sellers, City Engineer, Lansing, Mich.

M. C. Taft, City Engineer, Kalamazoo, Mich.

William Vincent, Civil Engineer and Surveyor, Manistee, Mich.

T. O. Williams, Civil Engineer and Surveyor, Grand Rapids, Mich.

George F. Bristol, Civil Engineer, Grand Rapids, Mich.

Charles Cummings, Surveyor and Civil Engineer, Marquette, Mich.

FOR JUNIOR MEMBER.

John T. Nellist, Surveyor and Draughtsman, Grand Rapids, Mich.

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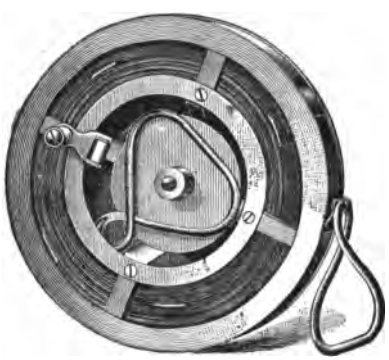

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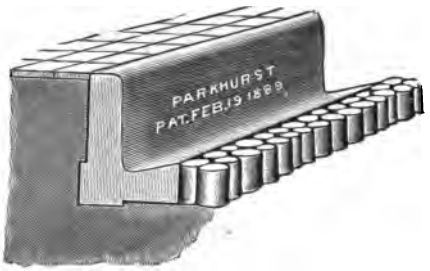

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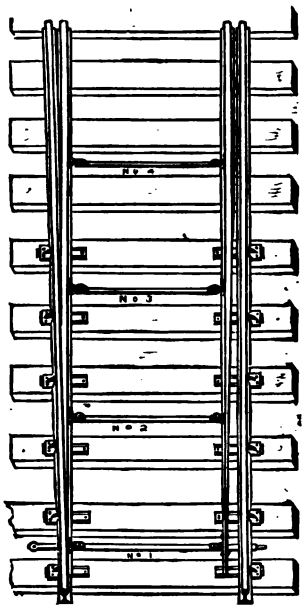

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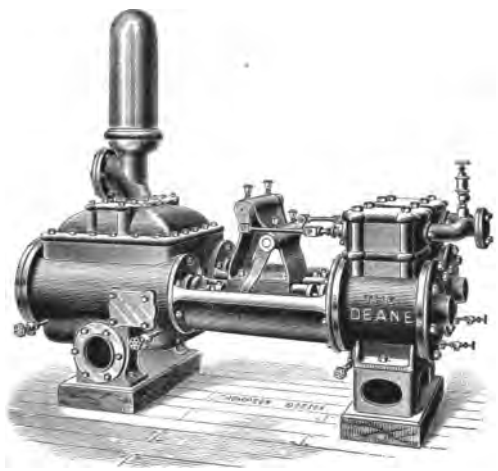

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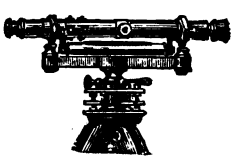

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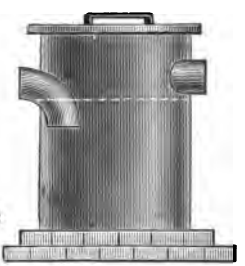

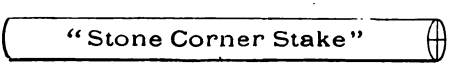

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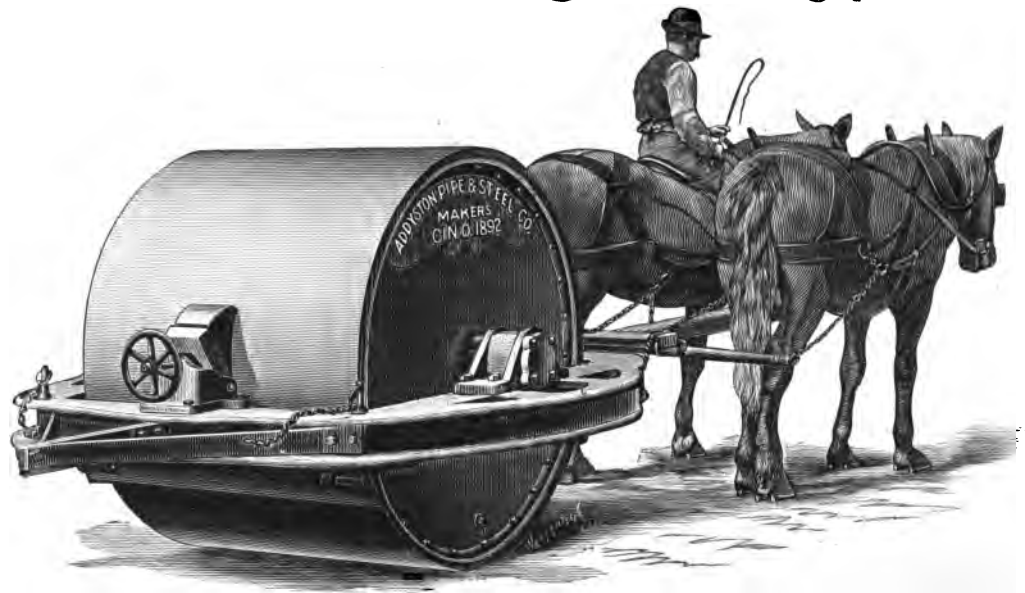

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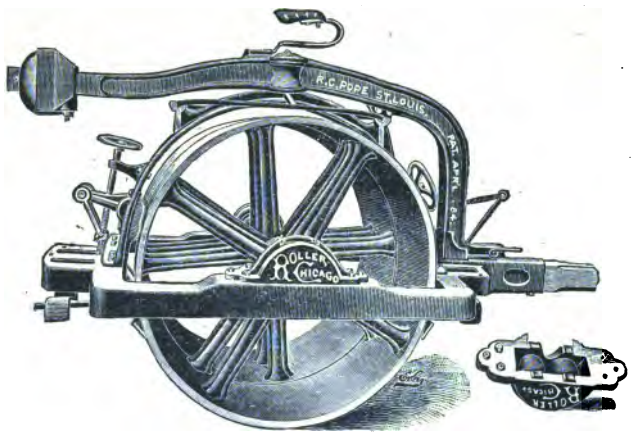

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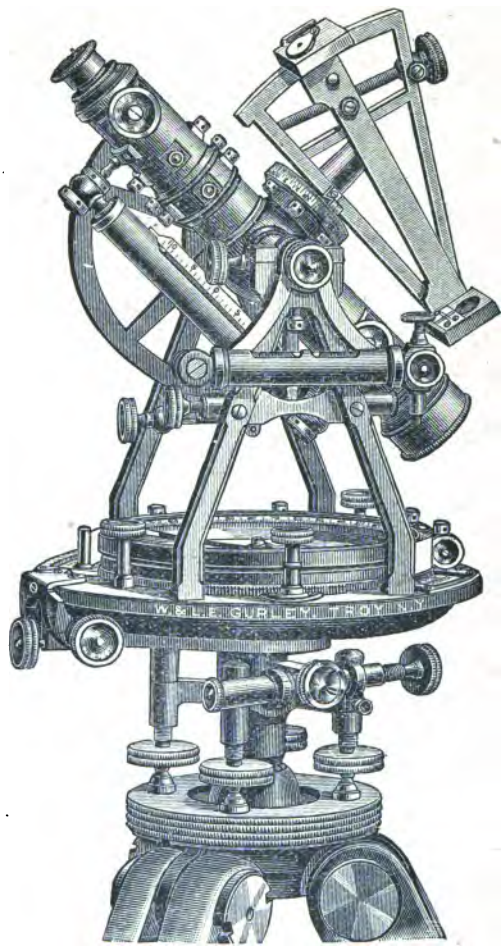

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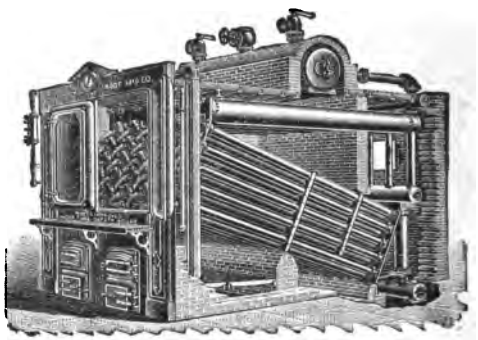

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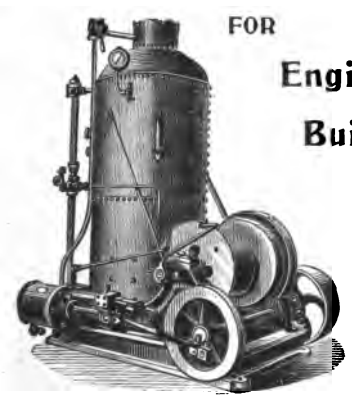

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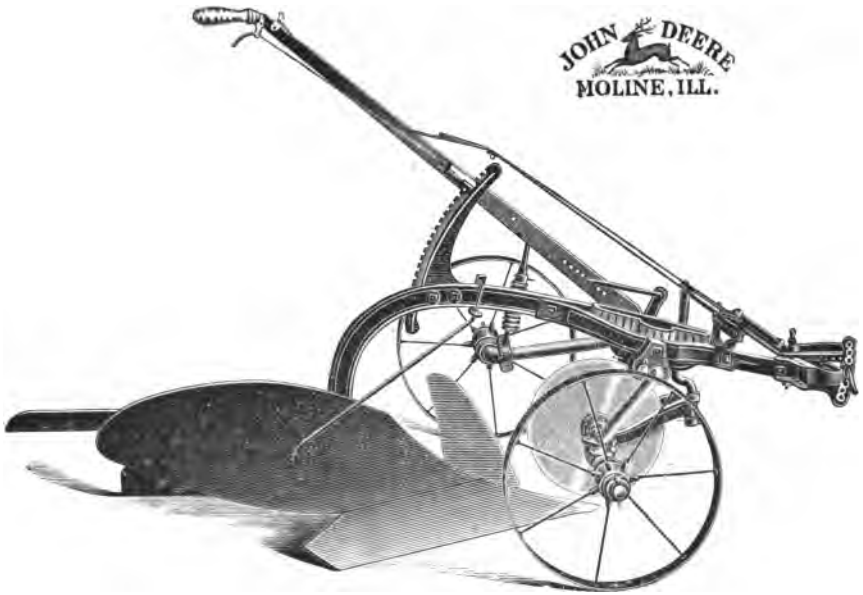

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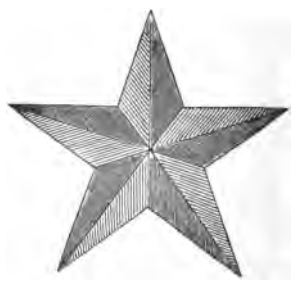

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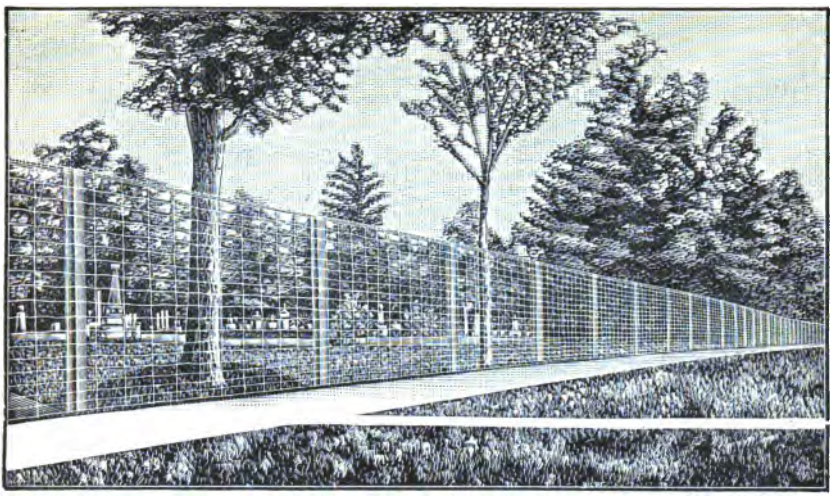

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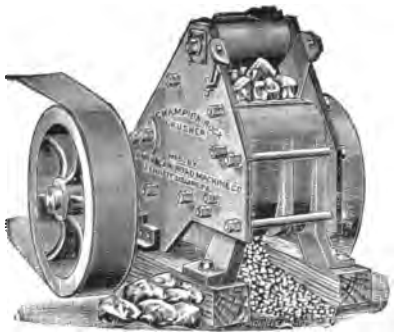

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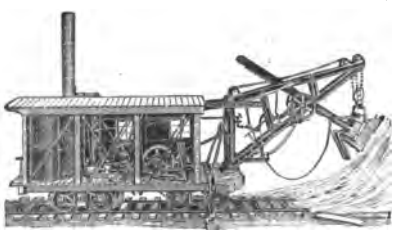

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ANNUAL CONVENTION, 1894.

PAPERS AND DISCUSSIONS.

ANSWERS TO ENGINEERING QUERIES.

E. W. MUENSCHER.

It was the lot of the writer to enter upon the practice of engineering at a time when the work of the profession was not so divided up into specialties, as it has since become, and a large proportion of the aspirants of that day were obliged to take such employment as they could get, passing from one branch of work to another as opportunity offered or necessity required, and thus acquiring rather an extended but somewhat superficial acquaintance with several branches than a profound knowledge of any one. During a practice of this character, now extending over a period of more than thirty years, during which he was initiated as back flagman on a railroad survey, passed to the degree of city engineer, and raised to the sublime degree of a county surveyor the writer has had in his employ many bright and promising young men, some of whom have since risen to responsible and important positions. Some of these young men, as well as others who have never been in his employ, have referred to the writer some of the troublesome questions which have arisen in their own practice. The substance of the replies which have been given to some of these questions is given in this paper, in the hope that it may be of service to some of the younger members of this society, who may possibly have to deal with some of these questions themselves.

First—Application of transition curves to race tracks.

A gentleman writes from the Province of Ontario that he has been trying the method of laying out transition curves described in the "Annuals" of this society for 1891 and 1892 in easing off the circular curves of a regulation race track, one mile in length, and finds that it does not fit precisely. The track without easements would consist of two parallel straight stretches 1,320 feet long, and 840 feet 4 inches apart, connected by two semicircular arcs each 1,320 feet long. He says, "The radius of the circular curve being 420′ 2′′, $D=$ 13° 40.2′, and deflection angle for 200′ taper $=4°\ 33\frac{1}{3}'$. Setting up instrument at *O* (*P. C. C.*) (and deflecting 9° $06\frac{2}{3}'$ from chord *A O* to get tangent), I commenced putting in the circular curve, using the radius 420′ 2′′, but chords of 25 feet instead of 100; the deflection for 25 feet being 1° 42′ 16′′; but, instead of keeping the same distance from the circular curve (if no taper had been used), I kept approaching the true circular curve, and when nearing the second *P. C. C.* the two curves coincided, which is contrary to what I was led to expect from reading your paper. I then ran one-half the curve from each end, and found myself out only six inches when I met in the middle at C, which error I distributed among three stations on each side. I found the lengths of the curves from *P. C. C.* to *P. C. C.* to be 1,112.4 and 1,112.7 feet respectively, instead of 1,119.4, as it should have been for a circular curve—using chords of 25 feet, necessitating the lengthening of the tangents."

The following was the substance of the reply to this letter:

The method of laying out easement curves described in the Michigan Engineers' Annuals for 1891 and 1892 was intended for use in ordinary cases of *railroad* curves of moderate degrees of curvature, where the variations from exact mathematical precision would be so small as to be immaterial, and where extreme nicety of alignment is not necessary. I have never had occasion to use it in laying out a race track, and, in fact, hardly anticipated its application to so extreme a case. Since, however, your letter has called my attention to the matter, I think it will be found that there need be no difficulty in applying the general method even in this case.

To do this, however, will require a little preliminary calculation, and it will be necessary also to always bear in mind three important practical points.

First, That even the most favorable natural surface of ground makes a rough drawing board, and that to lay out a semicircle of 13° 40′ curve from one end by chords and deflection angles, and hit the tack at the other end exactly, is a feat that requires an excellent instrument and the utmost care on the part of even expert transitmen and tapemen. In fact it is very seldom accomplished.

Second, That in an arc of given radius the degree of curvature (the D of the field books) is not precisely the same for chords of different lengths, as, for example, 100 and 25 feet. Thus in your case of a semicircle with radius 420.17 feet, if 100 feet chords are used $D=13°\ 40'$ almost exactly, but if 25 feet chords are used $D=3°\ 24'\ 33''$, since $Sin\ \frac{1}{2}\ D=\frac{chord}{2\times radius}$, and $3°\ 24'\ 33''\times 4=13°\ 38'\ 12''$.

Third, That the *length* of the curve will be different if measured on the *arc* from what it is when measured on the *chords*, and that its length will also vary if measured by chords of different lengths.

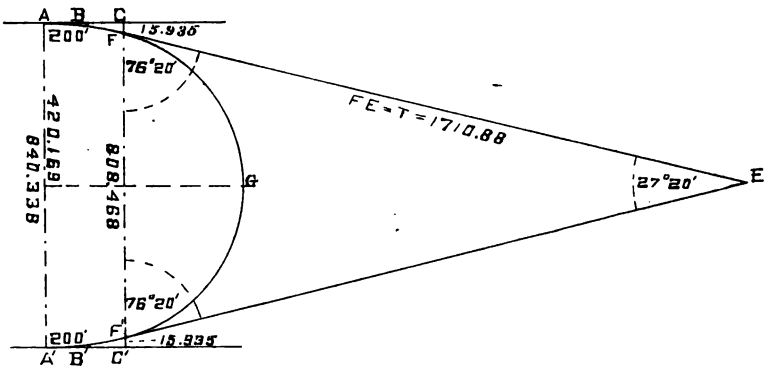
This is an important point, because in race tracks the measurement must always be reckoned on the *arc*, while in railroad work we deal only with *chords*, and the precise length of the arc is of little moment. Thus in your case the length of the semicircular arc should be 1,320 feet, but, since there are 10800′ and 648000′′ in 180°, the length by chords of 100 feet would be $\frac{180°}{13°\ 40'}\times 100'=\frac{10800'}{820'}\times 100'=1317.07'$, or nearly three feet less than on the arc, and by chords of 25 feet $\frac{180°}{3°\ 24'\ 33''}\times 25'=\frac{648000''}{12273''}\times 25'=1319.97$ feet, showing that the difference between the arc and the 25 feet chords is inappreciable.

Probably all three of these facts concurred in causing the discrepancies in measurement which you mention, and will always tend to produce a similar result. The first difficulty can only be overcome by extreme care at the transit and the tape, and the second and third by using chords of 25 feet with the precise value of D for chords of that length.

Let us now apply these considerations to the case in point.

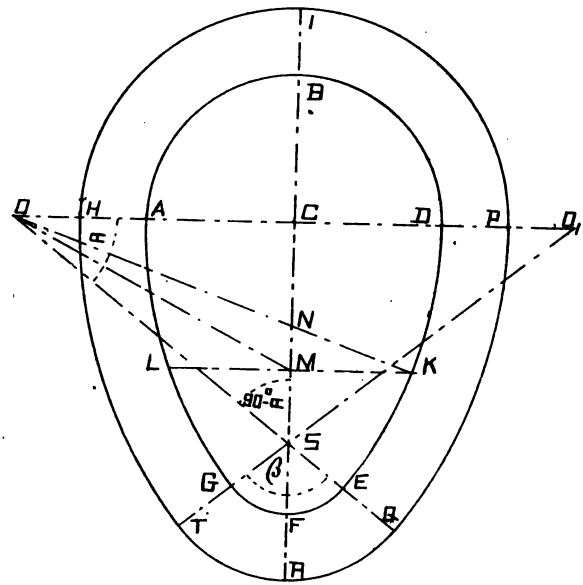
In the figure let B and B^1 be the $P\ C$ and the $P\ T$ of a semi-circular curve without easement, $A\ F$ and $A^1\ F^1$ the easement curves, each 200 feet long, $F\ E$ and $F^1\ E$ the tangents of the central circular curve $F\ G\ F^1$. The interior angle at E, $F\ E\ F^1 = 2\ D = 27°\ 20'$. The deflection angle at A being $\frac{1}{3}\ D$ ($=4°\ 33\frac{1}{3}'$, of which nat tan $=.079677$), and the distance $A\ F = 200$ feet, the offset from the tangent, $C\ F$ (or $C^1\ F^1$) $=079677 \times 200 = 15.935$. Hence $F\ F^1 = 840.338 - 2 \times 15.935 = 808.468$. The triangle $F\ E\ F^1$ being isosceles the angles at F and F^1 are each $76°\ 20'$ and the triangle gives $F\ E = F\ F^1 \frac{Sin\ 76°\ 20'}{Sin\ 27°\ 20'} = 1710.88$. Then from the formula $R = T \times \cot \frac{1}{2}\Delta$ we have $1710.88 \times \cot 76°\ 20' = 416.02$ for the radius of the arc $F\ G\ F^1$. The value of D will be for 100 feet chords $13°\ 48'\ 19\frac{1}{2}''$, and for 25 feet chords $3°\ 26'\ 36''$. The length of the curve by 100 feet chords will be $\frac{152°\ 40'}{13°\ 48'\ 19\frac{1}{2}''} \times 100 = 1105.84$, and by 25 feet chords $\frac{152°\ 40'}{3°\ 26'\ 36''} \times 25 = 1108.42$, and the length of the arc $= 416.02 \times 2\ \pi \times \frac{152°\ 40'}{360°} = 1108.50$. Adding to this the two easement curves gives 1508.50 for the entire length of the curve $A\ G\ A^1$. Subtracting this from 2640, (the half length of the track,) we get 1131.50 for the correct length of each straight stretch. By taking the $P\ T\ C$ of the easement just 100 feet back from the original $P\ C$ of a semicircle the tangent was reduced to 1,120 feet, which is 11.5 feet too short. The $P\ T\ C$ should therefore be moved forward at each end of the tangent $11\frac{1}{2} = 5.75$ feet, or, what would amount to the same thing, the tangent should be measured 1,131.5 feet long in the first place. Then put in the easements as directed in the "Annual" and the central curve of $152°\ 40'$ with 25 feet chords with $D = 3°\ 26'\ 36''$. The work will be more likely to fit correctly if half the curve is set out from each end.

By similar calculation we get for a half mile track radius of semi-circle $= 210.085$; $D = 27°\ 32'\ 13''$, angle at $E = 55°\ 4'\ 26''$ or $124°\ 55'\ 34''$, angle at $F = 62°\ 27'\ 47''$, $C\ F = 32.318$, $F\ F^1 = 355.533$; $F\ E = 384.51$, radius of central curve $= 200.48$, D for 25 feet chords $= 7°\ 8'\ 58''$, length of central arc $= 437.12$, length of entire curve $= 837.12$, length of straight stretch $= 482.88$.



Second—Dimensions of egg-shaped sewers.

A correspondent writes that he has been called upon to design some egg-shaped sewers, and that after looking carefully through every book in his possession he has been unable to find any formula by which he can calculate either the area or perimeter of such a sewer. The writer can thoroughly sympathize with this young gentleman, for he himself encountered precisely the same difficulty when he commenced designing sewers in 1869. At that date the accessible literature on the subject of sewerage was exceedingly meager; none of the great works which now furnish so much valuable information to the young engineer had made their appearance, and the writer, after searching far and wide, in vain, was obliged to work out a set of formulas for himself, which he has used ever since. It was not till four years later that some of these formulas, in their general form, were published in Latham's "Sanitary Engineering," together with tables based upon them. These tables have been copied in some subsequent reports, but no other text book or table book which has fallen under the writer's notice contains the formulas themselves. In the belief that they may be of value to some members of this society to whom Latham's work, now very scarce, is not accessible, and who may not have time for investigating the problem themselves, these formulas are here given, together with the process by which they are obtained, and some tables derived from them.



In the figure let A, B, D, E, F, G be the inner and H, I, P, Q, R, T the outer perimeter of an egg-shaped sewer, in which

$r = CA = CB = CD$ = radius of upper arch.

$r_1 = SE = SF = SG$ = radius of lower arch.

$R = OD = OE = O_1A = O_1G$ = radius of sides.

$h = AD = 2r$ = horizontal diameter of sewer.

$v = BF$ = vertical diameter of sewer.

$d = CS$ = distance between centers.

a = angle COS or $C\ O_1S$ subtended by the side arc DE or AG.

b = angle ESG subtended by the lower arc GFE.

$t = HA = BI = FR$ = thickness of brickwork.

$P = ABDEFG$ = inner perimeter of sewer.

A = Area of inside of sewer.

M = Hydraulic mean depth, or hydraulic mean radius.

For data for calculations we have r, r_1 and v, always assumed, and $\pi = 3.1415926536$.

Then from the figure we obtain:

$d=CS=BF-BC-SF=v-(r+r_1)$. (1)

$OC=OD-CD=R-r$. (2)

$OS=OE-SE=R-r_1$. (3)

$\overline{OC}^2+\overline{CS}^2=\overline{OS}^2$ or $(R-r)^2+d^2=(R-r_1)^2$ whence

$R=\frac{1}{2}\left\{\frac{d^2}{r-r_1}+r+r_1\right\}$ (4)

$Sin\ a=\frac{CS}{OS}=\frac{d}{R-r_1}$ (5)

Tang. $a=\frac{CS}{OC}=\frac{d}{R-r}$ (6)

$b=2(90°-a)$. (7)

Arc $ABD=\pi r$. (8)

Arc $AG=$ Arc $DE=\pi R\frac{a°}{180°}$ (9)

Arc $GFE=\pi r_1\frac{2(90°-a)}{180°}=\pi r_1\left\{1-\frac{a°}{90°}\right\}$ (10)

Adding together the arcs ABD, AG, DE, and GFE, and reducing we obtain

$P=\pi\left\{\frac{a°}{90°}(R-r_1)+r+r_1.\right\}$ (11)

Area $ABDA=\pi\frac{r^2}{2}$ (12)

Area $ODEO=O^1AGO^1=\pi R^2\frac{a}{360°}$ (13)

Area $OCSO=O^1CSO^1=\frac{OC\times CS}{2}=(R-r)\frac{d}{2}$ (14)

Area $ACSGA=DCSED=O^1AGO^1-O^1CSO^1=\pi R^2\frac{a}{360°}-(R-r)\frac{d}{2}$ (15)

Area $ESGFE=\pi r_1{}^2\frac{2(90°-a)}{360°}=\frac{\pi}{2}r_1{}^2\left\{1-\frac{a}{90°}\right\}$ (16)

Adding together the areas $ABDA$, $ACSGA$, $DCSED$, and $ESGFE$, and reducing we obtain

$A=\frac{\pi}{2}\left\{r^2+r_1{}^2+\frac{a}{90°}(R^2-r_1{}^2)\right\}-d(R-r)$ (17)

By a similar process we obtain

External perimeter, $HIPQTH=P+2\pi t$. (18)

External area $=A+(P+\pi t)t$. (19)

Area of ring or brickwork $=(P+\pi t)t$. (20)

$M=$Hydraulic radius$=\frac{Area}{Perimeter}=\frac{A}{P}$ (21)

By these general formulas all the elements of an egg-shaped sewer may be calculated whatever may be the ratio between the horizontal and vertical diameters, but the ratio almost universally adopted in this country is two to three.

Formerly it was the general custom to make $r_1=\frac{r}{2}=\frac{v}{6}$, but of late years it has become quite common to make $r_1=\frac{r}{4}=\frac{v}{12}$, which is better because it gives a slightly deeper current for the same volume of sewage.

In a sewer of these proportions by subtracting the arc ABD from P we obtain the wetted perimeter, and by subtracting the semicircle $ABDA$ from A we obtain the area when the sewer is two-thirds full, which is sometimes convenient. Drawing the horizontal line $L\,K$ through the point M, half way between C and F, and drawing $O\,K$ and $O\,M$, we can obtain by a somewhat tedious but not difficult process the arcs $A\,L$ and $D\,K$ and the areas $A\,C\,M\,L$ and $D\,C\,M\,K$, which being subtracted from the perimeter and area two-thirds full will give the perimeter and area one-third full.

Substituting in the general formulas the values $\frac{h}{v} = \frac{2}{3}$ and $r_1 = \frac{r}{2}$ for the old form or $r_1 = \frac{r}{4}$ for the new form, we obtain for the elements of these two forms the following values, all of which are carried out to several more places of decimals than there is any necessity for using in practice:

Elements.		Old form.	New form.
$CA = CB = CD$	r	r	r
AD	h	$2r$	$2r$
BF	v	$3r$	$3r$
$SE = SF = SG$	r_1	$\frac{r}{2} = \frac{v}{6}$	$\frac{r}{4} = \frac{v}{12}$
CF		$2r$	$2r$
CS	d	$1\frac{1}{2}r$	$1\frac{3}{4}r$
CM		r	r
$OD = OK = OE = O_1A = O_1G =$	R	$3r$	$2\frac{2}{3}r$
$OC = O_1C$		$2r$	$1\frac{2}{3}r$
$OS = O_1S$		$2\frac{1}{2}r$	$2\frac{5}{12}r$
Angle $COS = CO_1S$	a	36°52′11″.736264	46°23′49″.885434
	$\frac{a}{360}$	0.102416463	0.128881084
Angle ESG	b	106°15′36″.527472	87°12′22″.229133
	$\frac{b}{360}$	0.295167074	0.242237831
Perimeter full	P	$r \times 7.9298970582$	$r \times 7.8409455405$
" "		$v \times 2.6432990194$	$v \times 2.6136485135$
" $\frac{2}{3}$ full		$r \times 4.7883044046$	$r \times 4.6993528869$
" $\frac{1}{3}$ "		$r \times 2.7493442838$	$r \times 2.6650732593$
Area full	A	$r^2 \times 4.5941345444$	$r^2 \times 4.4601550733$
" "		$v^2 \times 0.5104593938$	$v^2 \times 0.4955727859$
" $\frac{2}{3}$ full		$r^2 \times 3.0233382176$	$r^2 \times 2.8893587465$
" $\frac{1}{3}$ "		$r^2 \times 1.1364032364$	$r^2 \times 1.0171398138$
Hydraulic mean depth full	M	$r \times 0.579343$	$r \times 0.568836$
" " " $\frac{2}{3}$ full		$r \times 0.631400$	$r \times 0.614842$
" " " $\frac{1}{3}$ "		$r \times 0.413336$	$r \times 0.381655$

For all practical purposes we may take for either the old or new form $P = 2\frac{5}{8}v$ and $A = \frac{1}{2}v^2$. (22)

If p = perimeter, a = area and x = radius of a circular sewer, and we make $x = r$ we shall have

$a : A :: r^2 \times 3.14159 : r^2 \times 4.59413$ from whence

area of circle : area of oval of same horizontal radius :: 1 : 1.46 (23)

If we make $a = A$ we shall have

$x^2 \times 3.14159 = r^2 \times 4.59413$ from whence

For old form $r = x \times 0.8269$ (24)

" new " $r = x \times 0.8393$ (25)

In either form $r = \frac{5}{6} x$ very nearly (26)

The formulas commonly used for obtaining the necessary size of the sewer required to drain a given area usually give the diameter of a circular sewer. Taking $\frac{5}{6}$ of this result will give the horizontal diameter of the egg-shaped sewer having the same area, and approximately the same discharge.

When $a = A$ we have also

$P : p :: r \times 7.929897 : 2x \times 3.141592$

$:: x \times 0.8269 \times 7.929897 : x \times 6.283185$

$:: 1 : 0.9582.$

This shows that an egg-shaped sewer requires about 4 per cent more brick than a circular sewer of the same area.

NUMBER OF BRICK REQUIRED.

In an ordinary wall the number of brick required may be determined approximately by dividing the entire volume of the wall by the average volume of one brick increased by that of the mortar joints on three sides. This method does not apply to sewers because the brick are laid as nearly as practicable with their faces parallel and normal to the perimeter of the sewer. We must first find the number of brick required to go round the sewer by dividing the perimeter, P, by the *thickness* of a brick, increased by that of the mortar joint at the inner edge, if the brick are not laid close together at that edge. Multiply the number thus found by 12 (inches) and divide by the sum (in inches) of the *length* of a brick and the thickness of the mortar joint at one end, and we obtain the number of brick required for each foot of length of the sewer for a *single* course. If there should be a *second* course substitute for t in

equation (18) the sum of the *width* of a brick and the thickness of the mortar joint between the two courses, if there is to be any such joint. The equation will then give the value of P to be used in determining the number of brick in the second course. If there should be more than two courses proceed in a similar manner for each course. For example let the brick be $8'' \times 4'' \times 2''$, and the mortar joints at the inner edge, end and back to be each $\frac{1}{4}''$. Then in a sewer of the old form (supposing r to be in feet)

1st course. To go round, $No. = \frac{7.93r \times 12}{2.25} = 42 \times r$

In one foot of length, $No. = \frac{42 \times r \times 12}{8.25} = 61 \times r$

2d course. Perimeter $= 7'.93 \times r + 2\ \tilde{n} \times \frac{4''.25}{12''} = 7.93 \times r + 2'.2253$

To go round, $No. = (7.93 \times r + 2.2253)\ \frac{12}{2.25} = 42 \times r + 12$

In one foot of length, $No. = (42r + 12)\ \frac{12}{8.25} = 61 \times r + 17.4$

Multiplying the number of brick in one foot by the volume of one brick, and subtracting the product from the area of the ring obtained by equation (20) will give the volume of mortar required per foot of length.

By means of these formulas tables of brick work can be readily calculated for sewers of different sizes, which would save much time and labor, but the dimensions of brick and the thickness of mortar joint in use vary so greatly in different localities that each engineer can best calculate such tables for himself.

Following are tables calculated by the foregoing formulas of the elements of egg-shaped sewers of both the old and the new forms of various sizes up to $5' \times 7\frac{1}{2}'$. Above this size the egg-shape is seldom used, and when used the elements can readily be obtained from the formulas.

Elements of egg-shaped sewers—Old form.

Size of sewer.	Wetted perimeter.			Sectional area.			Hydraulic mean depth.		
	Full.	⅝ Full.	⅓ Full.	Full.	⅝ Full.	⅓ Full.	Full.	⅜ Full.	⅓ Full.
	Feet.	Feet.	Feet.	Sqr. ft.	Sqr. ft.	Sqr. ft.	Feet.	Feet.	Feet.
1′ 0″ x 1′ 6″	3.9649	2.3942	1.3747	1.1485	0.7558	0.2841	0.2897	0.3157	0.2067
1′ 2″ x 1′ 9″	4.6258	2.7932	1.6038	1.5633	1.0288	0.3867	0.3379	0.3683	0.2411
1′ 4″ x 2′ 0″	5.2866	3.1922	1.8329	2.0418	1.3437	0.5051	0.3862	0.4209	0.2756
1′ 6″ x 2′ 3″	5.9474	3.5912	2.0620	2.5842	1.7006	0.6392	0.4345	0.4735	0.3100
1′ 8″ x 2′ 6″	6.6082	3.9903	2.2911	3.1904	2.0995	0.7891	0.4828	0.5261	0.3444
1′ 10″ x 2′ 9″	7.2691	4.3893	2.5202	3.8603	2.5404	0.9549	0.5311	0.5787	0.3789
2′ 0″ x 3′ 0″	7.9300	4.7883	2.7493	4.5941	3.0233	1.1364	0.5793	0.6314	0.4133
2′ 2″ x 3′ 3″	8.5907	5.1873	2.9785	5.3917	3.5482	1.3337	0.6276	0.6840	0.4478
2′ 4″ x 3′ 6″	9.2515	5.5864	3.2076	6.2531	4.1151	1.5468	0.6759	0.7366	0.4822
2′ 6″ x 3′ 9″	9.9124	5.9854	3.4367	7.1783	4.7239	1.7756	0.7242	0.7892	0.5167
2′ 8″ x 4′ 0″	10.5732	6.3844	3.6658	8.1673	5.3748	2.0203	0.7725	0.8418	0.5511
2′ 10″ x 4′ 3″	11.2340	6.7834	3.8949	9.2201	6.0677	2.2807	0.8207	0.8944	0.5856
3′ 0″ x 4′ 6″	11.8948	7.1825	4.1240	10.3368	6.8025	2.5569	0.8690	0.9471	0.6200
3′ 2″ x 4′ 9″	12.5557	7.5815	4.3531	11.5172	7.5793	2.8489	0.9173	0.9997	0.6544
3′ 4″ x 5′ 0″	13.2165	7.9805	4.5822	12.7615	8.3981	3.1567	0.9656	1.0523	0.6889
3′ 6″ x 5′ 3″	13.8773	8.3795	4.8114	14.0695	9.2590	3 4802	1.0139	1.1049	0.7233
3′ 8″ x 5′ 6″	14.5381	8.7786	5.0405	15.4114	10.1618	3.8196	1.0621	1.1575	0.7578
3′ 10″ x 5′ 9″	15.1990	9.1776	5 2696	16.8771	11.1066	4.1747	1.1104	1.2101	0.7922
4′ 0″ x 6′ 0″	15.8598	9.5766	5.4987	18.3765	12.0934	4.5456	1.1587	1.2628	0.8267
4′ 2″ x 6′ 3″	16.5206	9.9756	5.7278	19.9398	13.1221	4.9323	1.2070	1.3154	0.8611
4′ 4″ x 6′ 6″	17.1814	10.3747	5.9569	21.5669	14.1929	5.3348	1.2552	1.3680	0.8956
4′ 6″ x 6′ 9″	17.8423	10.7737	6.1860	23.2578	15.3058	5.7530	1.3035	1.4206	0.9300
4′ 8″ x 7′ 0″	18.5031	11.1727	6.4151	25.0125	16.4604	6.1871	1.3518	1.4732	0.9645
4′ 10″ x 7′ 3″	19.1639	11.5717	6.6442	26.8310	17.6571	6.6369	1.4001	1.5258	0.9989
5′ 0″ x 7′ 6″	19.8247	11.9708	6.8734	28.7133	18.8958	7.1025	1.4484	1.5785	1.0333

Elements of egg-shaped sewers—New form.

Size of sewer.	Wetted perimeter.			Sectional area.			Hydraulic mean depth.		
	Full.	⅝ Full.	½ Full.	Full.	⅝ Full.	½ Full.	Full.	⅝ Full.	½ Full.
	Feet.	Feet.	Feet.	Sqr. ft.	Sqr. ft.	Sqr. ft.	Feet.	Feet.	Feet.
1' 0" x 1' 6"	3.9205	2.3497	1.3325	1.1150	0.7223	0.2543	0.2844	0.3074	0.1908
1' 2" x 1' 9"	4.5739	2.7413	1.5546	1.5177	0.9832	0.3461	0.3318	0.3587	0.2226
1' 4" x 2' 0"	5.2273	3.1329	1.7767	1.9828	1.2842	0.4521	0.3792	0.4099	0.2544
1' 6" x 2' 3"	5.8807	3.5245	1.9988	2.5088	1.6253	0.5721	0.4266	0.4611	0.2862
1' 8" x 2' 6"	6.5341	3.9161	2.2209	3.0973	2.0065	0.7063	0.4740	0.5124	0.3180
1' 10" x 2' 9"	7.1875	4.3077	2.4430	3.7478	2.4279	0.8546	0.5214	0.5636	0.3499
2' 0" x 3' 0"	7.8409	4.6994	2.6651	4.4602	2.8894	1.0171	0.5688	0.6148	0.3817
2' 2" x 3' 3"	8.4944	5.0910	2.8872	5.2345	3.3910	1.1937	0.6162	0.6661	0.4135
2' 4" x 3' 6"	9.1478	5.4826	3.1093	6.0708	3.9327	1.3844	0.6636	0.7173	0.4453
2' 6" x 3' 9"	9.8012	5.8742	3.3313	6.9690	4.5146	1.5893	0.7110	0.7686	0.4771
2' 8" x 4' 0"	10.4546	6.2658	3.5534	7.9292	5.1366	1.8082	0.7584	0.8198	0.5089
2' 10" x 4' 3"	11.1080	6.6574	3.7755	8.9513	5.7989	2.0425	0.8059	0.8710	0.5407
3' 0" x 4' 6"	11.7614	7.0490	3.9976	10.0353	6.5011	2.2886	0.8533	0.9223	0.5725
3' 2" x 4' 9"	12.4148	7.4406	4.2197	11.1814	7.2443	2.5518	0.9007	0.9735	0.6043
3' 4" x 5' 0"	13.0682	7.8323	4.4418	12.3893	8.0260	2.8254	0.9481	1.0247	0.6361
3' 6" x 5' 3"	13.7217	8.2239	4.6639	13.6592	8.8487	3.1150	0.9955	1.0760	0.6679
3' 8" x 5' 6"	14.3751	8.6155	4.8860	14.9911	9.7115	3.4187	1.0429	1.1272	0.6997
3' 10" x 5' 9"	15.0285	9.0071	5.1081	16.3846	10.6144	3.7401	1.0903	1.1784	0.7315
4' 0" x 6' 0"	15.6819	9.3987	5.3301	17.8406	11.5574	4.0686	1.1377	1.2297	0.7633
4' 2" x 6' 3"	16.3353	9.7903	5.5522	19.3588	12.5406	4.4147	1.1851	1.2809	0.7951
4' 4" x 6' 6"	16.9887	10.1819	5.7743	20.9379	13.5639	4.7749	1.2325	1.3322	0.8269
4' 6" x 6' 9"	17.6421	10.5735	5.9964	22.5795	14.6274	5.1493	1.2799	1.3834	0.8587
4' 8" x 7' 0"	18.2955	10.9652	6.2185	24.2830	15.7310	5.5378	1.3273	1.4346	0.8905
4' 10" x 7' 3"	18.9490	11.3568	6.4406	26.0485	16.8747	5.9404	1.3747	1.4859	0.9223
5' 0" x 7' 6"	19.6024	11.7484	6.6627	27.8760	18.0585	6.3571	1.4221	1.5371	0.9541

SOME NOTES ON THE COMPILATION OF PROPERTY MAPS.

W. G. FARGO.

It is the intention to offer in this paper a few suggestions to those who are for the first time contemplating the publication of a property map.

A well known atlas publisher recently gave it as his opinion that upwards of 90 per cent of those who undertook the compilation of a local map or two lost money on the venture. This is an unfortunate fact, both for the would-be compiler and the public generally, for it is evident that a surveyor who is familiar with the peculiarities of property lines in a city or township is

often better qualified than a stranger to compile a correct map of the same. There are a number of reasons why a company constantly engaged in the publication of maps and atlases can do so at a profit, while local parties without previous experience in this line would lose on the same work. It is not the intention to discuss here the business methods of map concerns, but to describe briefly some suitable processes of engraving and coloring, and how to prepare the original drawings therefor.

Taking for instance the case of a city or village of which there is no existing map. The first step would be to obtain copies of *all* recorded plats; these can be cheaply made on tracing paper, in pencil, except the figures, etc., which had better be written in with ink. Copy also the written description of the boundaries of the plat or plot it on the tracing in red ink, noting also in red the distances and courses on their respective lines. Next take the last assessor's roll and obtain descriptions of unplatted property coming within the limits of the proposed map. These descriptions and the name of the owner as given by the assessor should be checked up on the ground or by the aid of title abstract books.

For a frame-work or system of base lines for the map, select long and straight streets crossing the city at right angles to each other if possible, and from half to one mile apart. Make continuous measurements on each of these streets, noting "pluses" of intersecting street lines as occupied, also all railroad tracks, streams, section and subdivisional lines of sections, etc. Two men with a 100-foot tape and a third man as recorder will do this work very rapidly. The angles of the lines comprising this skeleton may then be taken with a transit.

If the scale adopted will admit, it is desirable to show all, or nearly all, railroad sidings and spurs. The maps filed by railroad companies at the office of register of deeds in Michigan are sometimes of service but often on too small a scale or too destitute of written data to be available for a large scale city map. Unless the office of the engineer department of the railroad is near at hand and affords a large scale map of the line, showing the desired data, the privilege of using which can be had without too much "red tape," it will be found more satisfactory to make special surveys of all tracks. Much of this

work, as well as surveys of rivers and streams, can be advantageously done with a transit having stadia wires or other means for obtaining distances. If it is desired to map both banks of a broad river, an excellent plan is to make the survey on the ice, setting the transit at stations 800 or 1,000 feet apart as near the center of the stream as may be determined by eye and using two or more stadia rodmen to take points along the banks; reading the limb from 0° to 360° and carrying the azimuth as in a traverse survey. This traverse should commence at and close upon previously established points in the base line system. The angles thus taken may be conveniently platted with a full circle protractor. These may be had about fourteen inches in diameter printed on drawing paper and graduated to quarter degrees, and are easily read to the nearest five minutes. The central part of this protractor should be cut away, so that a flap carrying the center point folds back out of the way after the protractor has been oriented on the drawing; allowing the readings to be plotted directly from a scale whose zero point is placed at the station point and whose edge is swung around to the given bearings.

There are three methods of engraving suitable for a large scale city map: lithography, the wax process and zinc etching. A lithographed map is put upon the stone in three general ways; by being redrawn on the stone reversed in lithographer's ink or "turch" from the original drawing, which must be in the same scale as the prints are to be; by photo-transfer from a carefully lettered original drawing which must be totally void of color except dead black ink; or when the original drawing is executed in transfer ink upon transfer paper (to be had of any lithographer), a transfer may be made directly onto the stone.

Drawings for photo-lithography are preferably drawn to a larger scale than the finished prints are to be. The reduction to the desired scale is made by photography before transferring to the stone. This reduction serves two purposes, it sharpens the original drawing, or causes any slight roughness of the pen work to be less apparent, and it allows the letters and figures to be made on a larger scale, and hence with less difficulty by the draughtsman. The original drawing should not be more

than about one and one-half times what the finished prints are to be. Thus, if the scale of the printed maps is desired to be 400 feet per inch, the original drawing may be 300 feet per inch, or if 300 feet per inch is the scale desired, the original drawing may be 200 feet per inch. Much greater reduction than this is not advisable. Considerable skill in making the original drawing is required to obtain the best results by any photo-transfer process. The drawing must be clean and sharp, and the draughtsman must constantly bear in mind the effect of the reduction upon the width of the lines and the size and spacing of the letters and figures. The finest line should be perfectly black, though a slightly brownish tinge will not be injurious; but fine lines are the hardest to reproduce in the negative, and if they are lighter in tone than the heavy ones, presenting a grayish or brownish appearance, they are liable to be lost in the engraving.

The paper on which a drawing for photo-reproduction is made should be pure white in color, having a perfectly smooth surface, and must not be calendered or shiny; as the reflection from the surface would interfere with photographing. Bristol board is generally recommended for the purpose, but many samples of bristol boards pick up badly under a fine pointed pen, filling the pen with paper stock, and requiring constant cleaning. The writer has had better success with a heavy grade of unprepared blue print paper, the kind known as French satin paper. Hand-made drawing papers are inclined to cockle and contract unevenly after being damp stretched, which distorts the drawing. Then, too, the largest size of single sheet, 31x53 inches, is often too small.

The wax process makes a very neat map, as all letters and figures are in type. A smooth metal plate is covered with a thin coat of wax, the drawing is transferred to the wax, and the lines are engraved through the wax with pointed tools, to the surface of the metal plate. All letters and figures are made by pressing type through the wax until in contact with the metal plate. When the engraving is complete an electrotype is taken, which, as the drawing on the wax was a positive, will be a negative, and after blocking up is ready for the ordinary printing press. A wax process engraving of a city map

costs from ten to twenty-five cents per square inch. A city map on a scale of 400 feet to an inch, with dimensions of lots figured, and an average amount of railroad tracks, public buildings and water lining will cost from twenty to twenty-five cents per square inch to engrave by the wax process; which is the most expensive of the methods described for this kind of a map. For a small scale guide map of a city, showing no lot lines or numbers, the wax engraving is well adapted. Drawings for the wax process should be in the same scale as the engraving. Rand, McNally & Co., of Chicago, use the wax process almost exclusively.

For a zinc etching a finished drawing is made the same as for a photo-lithograph. This is photographed and a print made from a reversed negative on a polished zinc plate sensitised for the purpose. This zinc plate is then etched with acids so as to leave the lines in relief. A zinc etching costs from six to ten cents per square inch, and is best adapted to small maps, say up to twenty-four inches square. The reproduction of the original drawing by this process is very perfect, being usually somewhat better than by photo-lithography.

The inset sheets in Engineering News, each week, are reproduced by photo-lithography from enlarged drawings, and the outline drawings and diagrams occurring in the text are mostly zinc etchings. The style of letters and figures used on these drawings in Engineering News is especially well adapted to reproduction by photographic methods.

If it is desired to use flat tints in coloring the maps, the stencil method is the cheapest for a few hundred copies. For large editions it will be cheaper to print the colors in, necessitating a separate color stone or block for each color used.

Before making an estimate of cost of work which is to be redrawn on the stone, it will be necessary for the lithographer to see the copy, but for a photo-lithograph all he will need to know in order to furnish an estimate, is the size of finished maps, what coloring is to be done, number of copies wanted the kind of paper desired and style of mounting. Within certain limits the *size* of the map does not control the cost of a photo-lithograph job, as closely as it does with other methods of engraving. Hence, the photo-lithograph is to be recom-

mended on account of its cheapness and the satisfaction of knowing that when the original drawing is completed and "checked up," that the prints will be absolute reproductions. Very few engraving houses who do no lithographing, do their own press work. It is quite evident that more satisfactory work can be expected when the engraving, printing, coloring and mounting are all done at one establishment.

Among the medium priced papers, book-paper is best adapted to lithographic map-printing. This paper tears rather easily, and requires a backing of muslin, *i. e.*, it should be mounted. Line etchings print best on a highly calendered paper. Linen or bond papers are desirable on account of their toughness and durability, but are high in price and difficult to print upon.

Accurate property maps are a necessity to the business community, and the compilation of such a map can profitably occupy the time of a surveyor and his assistants when they would not be otherwise employed.

METHODS OF STONE QUARRYING.

H. G. ROTHWELL.

In treating this subject, I must confine myself more particularly to the sandstones, as my experience has been confined chiefly to these.

Sandstone on account of its wide distribution, its variety of colors, and its capabilities for cutting, carving, and finishing, both for plain and ornamental stone work in both public and private buildings, combined with its cost, in comparison to other classes of building stone, is one of the most largely used stones in the building trades.

The stone was deposited by nature in layers or beds, of varying thickness. In some instances these beds are so thick as to be called massive. The method of quarrying varies in its details somewhat to suit these conditions.

The principal form in which it is quarried out, is in what is

called dimension stone, say $8'+4'+2'$, or sizes approximating these figures, these blocks are sold by the cubic foot to builders and contractors, who cut them up to suit the various parts in the buildings erected. In getting out these blocks a considerable rubble stone is made, which is generally sold for a low figure or wasted.

Most of these sandstone quarries are covered over with a covering of glacial drift and shale rock varying in thickness from a few feet to fifty feet and even greater, these extreme depths, however, are not profitable as the cost of stripping the stone is too great, as all this covering has got to be removed before the stone is quarried.

The cost of this removal depends greatly on its nature and the facilities for wasting it.

After a stone quary has been stripped, the next process is to cut on the side on which it is proposed to open it, a channel, or more properly two channels, say about four feet apart and parallel, to the depth of the bed (if not too deep). This cutting is done generally by a steam channeling machine, of which there are many, such as the Wardwell, the Ingersoll Sergeant, the Sulivan steam channeler and Gadder, etc., all of which you will see illustrated in most all our leading engineering and mechanical papers. After these two channels are cut a portion is broken out or hand channeled across between the two channels, leaving a space from two to four feet wide according to the depth of the bed. This is called removing the key, and leaves a space in which the other stones can be moved as they are broken apart. This break is generally made by drilling two or three holes at right angles to the channels, and to nearly the depth of the bed, the stone can then be cracked or loosened by means of plugs and feathers (the old way), or by the use of the Knox blast. This process is the most modern and is a patented process, or rather the tool to do it with, which is a drill point that drills a hole larger at the bottom than at the top, making a chamber towards the base of the stone in which a small quantity of coarse blasting powder is placed, together with an electric exploder and the hole tamped, after which it is fired with a battery and the force of the concussion breaks the stone apart and moves it slightly on its bed. It then can be removed by the derrick.

After this key is removed the rest of the work is comparatively easy, as in what is called free bedded stone, all that has to be done is to cut channels transversely to the face, and drill a series of holes parallel to the face and using the same system of cracking it out. The stone are then, after being moved by the derrick, split up to the sized blocks required by means of wedges or *gads*, when the stone is piled up ready for shipment.

In quarries where the beds are massive, it requires much more work to be done. The channels are generally cut four feet apart and four feet deep, and the stone lifted apart by means of holes drilled horizontally part way across and wedges or gads used to crack it or lift it up, after which the stone is scabbled where necessary in order to true it up.

There is also another form of getting out stone by breaking it out as it will in irregular cubes. This form is sold by the ton and is called ton stone.

The various styles of machinery such as derricks, hoists, travelers, and drills, etc., used in quarrying are numerous and each has its advantages and are illustrated like the channeling machines in our various engineering and mechanical papers, and as many quarries on account of location and conditions in the stone call for a certain class of machinery which can be the most economically operated, the quarry superintendent has got to use good judgment in selecting the same.

FRANKLIN STREET BRIDGE.

BY E. O. SELLERS.

This structure is located over Grand river in the city of Lansing, Michigan.

To give a history of the inception of this public improvement would be to tell of such a flow of oratory, argument and bitterness as to move the most conservative audience almost to tears. Suffice it to say that after each of the city fathers and the city fathers' advisers had had their say, and the necessary bonds had been voted, the writer, who was at that time city engineer, A. D 1892, was instructed to advertise for plans and estimates for a bridge of low truss or girder design, to consist of two ninety-foot spans or three sixty-foot spans, the structure to have a roadway of 40 feet clear width and two sidewalks of 12 feet clear width each, with a capacity of 100 pounds per square foot over all. A prize of $100 was offered for the design to be adopted.

In response to advertisements in the Engineering News, and elsewhere, we received upwards of 20 different plans, specifications and estimates. The design of Mr. Benj. F. La Rue, C. E., of Jackson, Michigan, and a member of our society, was duly adopted.

Mr. La Rue's design was accompanied by an estimate of $17,000, and the statement that a bridge the full width of the street (79.86 feet) could be built within the appropriation, $25,000. All designs were for both substructure and superstructure. Mr. La Rue's advice being adopted he was directed to alter his plans accordingly.

The bridge, as designed, is of three 60-foot spans, each span consisting of five-plate girders 64 inches deep. These main girders were spaced 16 feet between centers; the three center or roadway girders were designed slightly heavier than the outer or sidewalk girders upon the assumption that the load upon these would be greater than upon the outer ones, both on account of the necessity of providing for heavy road-rollers,

electric street cars, etc., and also because the dead load of roadway is increased by the weight of the pavement.

The floor beams connecting the girders are 24 inches in depth and spaced 20 feet between centers; the floor joist consist of *I* beams of from seven inches to nine inches in depth and varying in weight from 15½ pounds to 21 pounds per foot; seven-inch beams beneath sidewalk, eight-inch under roadway and nine-inch under motor track. The lateral or sway bracing consists of 3′′ × 3′′ angle irons. A portion of the sidewalk, about eight feet in width, projects beyond the outer girder and is supported by brackets which are connected to, and form a part of the floor beams.

The road bed as finally decided upon is 49½ feet clear width, with a crown of six inches and consists of cedar block pavement laid upon three inch hemlock plank, the latter being dressed upon the upper surface and secured to the floor joist with wire nails clinched to the flanges of the *I* beams; subsequent orders caused these floor plank to be tarred, though personally I can see no lasting benefit to be gained by the use of tar upon one side of a board, or upon both for that matter, considering the condition of most of our so-called seasoned lumber. The pavement is of rectangular cedar blocks, sound timber only, six inches in length laid in courses at right angles with the center line of the street; the blocks are generally from 4 to 6 inches in width, all courses uniform throughout, and are held in place at the outer edges by oak strips 4 x 4 inches.

The pavement when completed was covered with about an inch of sand which was left in place about a week and then removed.

Considerable speculation was had as to whether this form of pavement (the blocks being laid tight) would not swell, upon being wet, and burst off the edging, but the writer has failed to notice any indication of its doing so as yet, neither is it out of position in any manner on account of freezing or other causes. I would add here that the motor track crossing this bridge consists of "*T*" rails laid upon 2 x 4′′ strips and spiked to the floor plank.

The cost of this form of pavement was between $2.50 and $3.00 per square yard.

The sidewalk consists of pine plank dressed upon the upper surface, laid with ½ inch spaces, and secured in the same manner as the roadway plank; the inner edge of the sidewalk is 6 inches above the surface of the pavement, drainage being effected underneath this edge of the sidewalk.

The sidewalk is 15.18 feet wide and in this width slopes 3 inches towards the road bed. The hand rail is of very heavy construction and handsome design; there being nothing unusual in its attachment.

All iron except rivets and hand rail is of medium steel, having an ultimate strength of from 60,000 to 68,000 pounds per square inch and an elastic limit of not less than one-half of its ultimate strength; it has an elongation of 20 per cent in 8 inches and a minimum reduction of area at point of fracture of 40 per cent. The specifications further called for a silky fracture and that it should bend cold 180 degrees on a diameter equal to the thickness of the piece tested without crack or flaw.

The rivets were of soft steel and had to stand the usual tests.

All iron, after proper cleansing, was given a coat of pure linseed oil before leaving the shop, and after erection was given two coats of good asphaltum paint.

The contract for the masonry, which is of extra large field boulders, was let separately, the better to give local contractors an opportunity to compete.

The foundation is coarse gravel, of about 16 feet in depth, overlaying the rock.

The excavation was carried only to a depth of about three feet, and the masonry started upon a bed of concrete composed of one part best American Portland cement, two parts clean sharp sand and five parts coarse gravel, mixed in the usual manner and placed in position with wheelbarrows.

The masonry is rough ashlar, laid in best American Portland cement mortar, all stone properly faced, bedded and jointed and joints neatly pointed.

The price paid for concrete was $4.11 and for masonry $6 per cubic yard. A competent superintendent was upon the work during the entire construction. The whole is covered with a coping of Berea sandstone six inches thick, except at girder

seats, where it is 12 inches, this thickness extending three feet each side of the center line of the girder.

The masonry was commenced in October and work prosecuted until about Christmas in order to take advantage of the low water, and while I can see no appreciable defects in that part laid during severe freezing weather, I am not satisfied that *first class* masonry can be properly constructed during such weather.

The piers were originally carried to the elevation given in the first plan, but as there was no authentic record of high water the advice of the oldest inhabitant proved of no avail, for when the rains descended and the ice came they scoured over our new piers and did much damage to them in their unfinished condition.

In order to gain more headway the depth of the girders was reduced 16 inches, the strength thus lost being made up by extra plates riveted to the top and bottom flanges, the grade of the bridge ends was raised six inches and the camber increased from three inches to 15 inches. Through these changes an average of 28 inches more headway was obtained, and as the highwater of the past winter exceeded anything known in years no further danger is apprehended.

While a camber of 15 inches in 180 feet is somewhat excessive, still from the surroundings and the grade of the street it rather adds to, than detracts from, the beauty of the bridge.

The dimensions of the masonry are as follows: Piers, $74 \times 4 + 13$ feet; abutments, $79.86 \times 5 \times 13$ feet; the whole together, with one short wing wall, containing a little over 1,000 cubic yards. The abutments are somewhat thinner than good retaining walls are generally built, advantage being taken of the fact of their being built outside of the old walls, which were allowed to remain standing.

Bids for the superstructure were invited upon four propositions: Bid "A," bridge full width of street, 79.86 feet; bid "B," originally intended width, 64 feet; bid "C," removing old bridge and erecting same at Logan street, a distance of nearly $2\frac{1}{2}$ miles; bid "D," extra for handrail over one in the design.

The old bridge occupying this site was a bow string girder of a design quite common 20 years ago; it consisted of two 100

feet spans, having a roadway 20 feet clear width, and two six-foot sidewalks. This bridge was erected in 1876 and had become insufficient to accommodate the rapidly increasing traffic. According to the conditions of the advertisement a certified check of $500 and a statement of the penalty per day for delay accompanied each bid. There were 13 bids submitted, and the Wrought Iron Bridge Co., of Canton, Ohio, secured the contract. They were a little less than three weeks erecting the bridge, and may well be pleased over the results of their labor.

The weight of the metal in the structure is about 170 tons.

The cost as finally reported is as follows:

1	Wrought Iron Bridge Co., bid "A"	$18,100 00
2	" " " " " "C"	850 00
3	" " " " " "D"	150 00
4	Changes in iron work	1,175 00
5	B. P. Coor, masonry	6,479 17
6	Plans, advertising and consultation	198 07
7	Superintendence	393 65
8	Extras (masonry) repairs, etc.	1,193 87
9	Paving approaches, etc.	210 14
10	Removing old wooden crib	71 85
11	Ice breakers to protect stone work	234 62
	Grand total of cost	$29,056 37

Deducting articles 2, 4, 8, 9 and 11, we find the actual cost of the bridge to have exceeded the appropriation but $392.74, a very fair showing.

A large local demonstration was had upon the completion of the structure, there was band playing, fireworks and speech-making galore.

The bridge is one that Lansing or any other city may point to as a prominent and excellent example of modern first class bridge design and construction.

At this time I desire to thus publicly express my sincere thanks to the consulting engineer, Mr. La Rue, and also to the Wrought Iron Bridge Co. for the kind and courteous treatment I received from them during all my connection with this structure, also to you gentlemen for your kind attention, and I hope that something may be gathered from this humble effort that may not be without value.

IRON AND STEEL.

C. E. GREENE.

There is some mistiness of view among people generally, if not among engineers, as to the difference between cast iron, wrought iron and steel; and this brief paper may, it is hoped, tend to clear the subject in some slight degree.

Speaking from the standpoint of the engineer who may have occasion to use the materials referred to, and not of the assayer or metallurgist, we may say that cast iron, wrought iron and steel differ from one another by reason of the amount of carbon contained in them. The proportion of this ingredient may range from perhaps five per cent to zero. While a portion of the carbon may be replaced by some other element, it is not thought wise to include such changes in this paper.

Cast iron contains the largest percentage of carbon, say from two to five per cent, which carbon it gets from the fuel. The ore, mixed with coal or charcoal, and with limestone as a flux for the earthy constituents of the ore, is melted in a blast furnace. The ore, fuel and flux are charged in at the top and the molton iron is drawn off at the bottom, the process being continuous. Although the slag floats on the melted iron, the cast pig, which has taken up all the carbon it has an affinity for, contains also some slag and other impurities. When broken, it is seen to be crystalline in appearance, and it differs in grade from white to gray cast iron, according to the temperature of the furnace and abundance of fuel. Gray cast iron is more fluid when melted than white iron, but it requires a higher temperature for its fusion. Gray iron melts at 1600° to 1700°c; white iron at 1400° to 1500°c. Gray cast iron contains *one* per cent, and sometimes less, of carbon in chemical combination with the iron, and from *one* to *three* or *four* per cent of carbon in the state of graphite or plumbago, in mechanical mixture; while white cast iron is a chemical compound of iron with from *two* to *four* per cent of carbon. Note that the melting point falls, and the hardness and brittleness increases, with the increase of

carbon in chemical combination. White cast iron is of no practical use in itself, but is used for making wrought iron. Gray iron is used in the trades, although civil engineers usually reject it in structural work as unreliable. The softest grade is probably the most fluid, and since it flows well into the mold, is used for making thin castings where strength is not required.

An intermediate grade can be converted from white cast iron to gray iron by fusion and slow cooling, and from gray to white by fusion and sudden cooling. This is the *chilling* iron, run into a mold lined with iron, which makes the surface in contact with the lining, for a depth of from half to three-fourths of an inch, intensely hard, as in the treads of car wheels. Compare this action with the hardening of steel. The tenacity of cast-iron may range from 15,000 pounds to 30,000 pounds per square inch, and its compressive strength from 60,000 pounds to 100,000 pounds. Such a crude product is improved by successive re-meltings.

Direct processes for making wrought-iron or steel from the ore may be employed, but they have generally been wasteful of iron. White pig iron is commonly melted in a cupola furnace and then run into a Bessemer converter or a reverberatory furnace for manipulation, which consists principally in its exposure to currents of air to burn out the excess of carbon. Other impurities may at the same time and by the same means be reduced in amount or burned out.

To explain why iron bars are fibrous: In the old-fashioned puddling furnace the surface of the melted pig iron is exposed to a blast rich in oxygen, and is stirred by the puddler to hasten the burning out of the carbon. As the carbon is thus removed the melting point rises and the iron becomes thick or pasty. Cast iron does not take on this intermediate state between fluid and solid, but wrought iron does, and hence can be *welded*. The semi fluid iron is collected into a lump by the puddler and withdrawn from the furnace. It is then like a sponge; the particles of wrought iron have adhered to one another, but each particle of iron is more or less coated with a little film of slag and oxide, as water is in the pores of a partly dry sponge.

The lump of iron is put into a squeezer, and the fluid slag and oxide drip out as water does from a squeezed sponge. But

as it is impracticable to squeeze a sponge perfectly dry so it is impracticable to squeeze all the impurities out from among the particles of metallic iron. In the subsequent processes of rolling and rerolling, each globule of iron is elongated, but still coated with this film of slag and oxide; so that the rolled bar consists of a collection of threads of iron. That wrought iron is fibrous is then an accident of the process of manufacture and not a property which is particularly beneficial. If these impurities had not been in the iron when it was rolled out it would have been more homogeneous and stronger. The appearance of fibre in the fracture of a bar which is nicked and bent is not especially indicative of toughness. Soft steel is tough and ductile without being fibrous. If the surface of an iron bar is planed smooth and then etched with acid, the metal is dissolved from the surface and the black lines of oxide are left distinctly visible. If the iron is twice cut up into pieces, piled, reheated, and rolled, it makes double refined iron, the grade used for good iron bridges, and superior to single refined iron, or merchant bars. The tensile strength of the former is about 50,000 lbs. varying with the size of the bars; that is, the more work done in rolling, the stronger the iron. The compressive strength, owing to its ductility, is rather low, from 36,000 lbs to 40,000 lbs.

Latterly, the manufacture of what is known as soft steel, or homogeneous metal, has been brought to such perfection that steel competes in price with wrought iron and drives it out of the market.

Steel is made from pig iron by several processes, the Bessemer, open-hearth, and others, all of which have for their main object the burning out of the carbon, either completely or nearly so. Some other substances which may be classed as impurities may also be reduced in amount at the same time. The process is a comparatively rapid one, several tons often being acted upon at once, and the heat generated by the union of the carbon with the oxygen of the air is sufficient to keep the mass fluid, although the melting point rises.

If the product, when practically freed from carbon, is run into molds, and the resulting ingots are rolled, the material is known as soft or mild steel, ingot iron or homogeneous metal,

but it is only iron freed from carbon, purer and stronger than wrought iron. Such a product when rolled is not fibrous, as puddled iron is, but is practically the same material, of a better quality. It will weld, but will not harden and temper. A steel structure therefore differs from an iron structure only in being made of a better grade of iron.

While the reduction of the amount of carbon may be stopped at a certain desired point, the carbon may be all removed and then the proper amount may be added to the charge to produce steel with a certain percentage of carbon. By this means the character of the product is more assured. The carbon is often added in the form of a certain cast iron, of definite composition, which also contains manganese, known as *spiegel-eisen*. The product of the Bessemer process is not usually so uniform in character as steel made by the open-hearth process, where time is afforded for testing the metal, and then bringing it to the desired grade.

Since steel is iron with a small percentage of carbon, it may be made by melting wrought iron with charcoal in a crucible, when the iron takes up carbon, and the product is known as crucible steel, or cast steel. This cast steel, when rolled, sheared up and rolled again, is shear steel, from which cutting tools are made. Such steel contains from 0.5 to 1.5 per cent of carbon.

The common soft steel which is used for tension members of bridges, and for pieces exposed to violent use, shocks and vibrations, does not probably contain more than 0.10 to 0.12 of one per cent of carbon. Steel, for compression members for instance, what is known as medium steel, will contain from 0.12 to 0.24 or 0.36 of one per cent. Thus, the structural steel will range from 0.12 to 0.36 of one per cent of carbon, which range is below the 0.5 of one per cent, given for common steel; and practically the steel used in structures is nothing more than iron under a different name.

Steel, properly so-called, will harden and temper, and it will not weld; but as the percentage of carbon falls off, it looses the property of hardening and tempering, and takes on the property of welding. Soft steel welds like wrought iron, and cannot be hardened to any extent. The chilling of a

certain grade of cast iron is analogous to the hardening of steel. The tensile strength of the softest steel runs from 50,000 to 60,000 lbs. per square inch. This steel is also used for boilers. The next or medium grade of steel will run from 60,000 lbs. to 70,000 lbs., and the steel which is used for columns may resist at failure from 70,000 lbs. to 80,000 lbs. Tool steel will go higher.

To recapitulate: Wrought or puddled iron is fibrous by reason of the way in which it is made; the hardest steel is crystalline; cast iron is granular.

Cast iron contains from two to five per cent of carbon, a part of which is in chemical combination, and the rest in mechanical mixture, in the form of graphite.

Cast iron contains the most carbon; steel, such as is used for machine and other tools, has a medium amount of carbon; the soft structural steel has very little, and some of it none at all, practically; and wrought iron has none.

There are two other products which might well be mentioned, and which will be seen to fit in between the three already described.

A small article, conveniently fashioned of cast iron, may be given an increase of strength, or its brittleness may be partly removed, by imbedding it in a substance rich in oxygen, as for instance, powdered red hemetite, sealing it up and keeping it at a high heat for some time. The oxygen abstracts the carbon from the surface, and converts the exterior into soft, malleable iron. Thus we have malleable iron castings.

If it is desired, on the other hand, to harden the surface of a wrought iron article, so that it will better resist wear, the piece may be buried in powdered charcoal and heated. The exterior will then absorb carbon and be converted into high steel. This process is known as case-hardening.

It will also follow that wrought iron scrap melted with cast iron will improve the latter.

THE PRESIDENT: I think you say steel contains from 0.12 to 0.15 of one per cent of carbon in the softer grades; medium steel, from 0.12 to 9.24, and hard steel, 0.24 to 0.36 of one per cent.

PROF. GREENE: Hard steel, for structural purposes is altogether different from the steel used to make tools of; the latter contains a larger proportion of carbon; the harder the steel the more brittle it is. The lower the percentage of carbon the more it loses its property of hardening, and the tougher it is.

THE PRESIDENT: Isn't there a disposition on the part of engineers now to use a little higher grade of steel?

PROF. GREENE: I should think in a heavy column or for a large span, it might be safer to use a higher grade of steel than in a lighter structure.

THE PRESIDENT: What effect have climate and temperature on soft steel?

PROF. GREENE: The hard steels are thought to be affected by cold more than the soft steels, but I do not think there is any sensible difference in the resistance of soft steels from change of temperature. Of course the question has been discussed as to the breakages of steel rails in cold weather. Some think such breakages are to be as much ascribed to the rigidity of the frozen road bed as to the action of cold on the steel.

THE PRESIDENT: Are they able to make this soft steel homogeneous without any difficulty? In getting out a number of bars of this soft steel, can they make it homogeneous as to strength?

PROF. GREENE: The product is usually quite uniform. Some engineers do not think that one should specify the chemical composition, if the physical characteristics are as desired—the elastic limit, ultimate strength, reduction of section and the elongation. The strength of the bars usually is regular. The best specifications have what you might call a sliding scale, by which they specify the strength of a bar; they take off a few hundred pounds for every inch of increase of section; for those smaller sections that have the most work done upon them, a higher strength can be specified; for a larger section, which has less work done upon it in rolling, a lower strength is demanded; the requirements are not so high. Wrought iron is decidedly increased in strength by wire drawing and the more work done upon the piece the stronger it will be. Steel has to be treated with much more care than iron in that respect.

MR. LA RUE: As to the practice of engineers in employing a higher grade of steel, I am inclined to think that it is in the other direction. They are apt to use a softer grade. I know that in a draw bridge built by Mr. C. Shaler Smith, in 1886, for the chords of the draw span he specified steel, to have an elastic strength of 90,000 lbs, and an elastic limit of 45,000 lbs, which is way beyond what is specified today for any bridge steel.

THE PRESIDENT: It is no doubt true that we know a great deal more about steel now than a few years ago. In this connection, I would like to ask Prof. Greene if he has, through observation or experience, any particular knowledge of the value of adding a small percentage of manganese? I have read that by adding $\frac{14}{1000}$ per cent of manganese, that a very tough, ductile, and at the same time very hard steel would be produced.

PROF. GREENE: I understand that in the Bessemer process manganese is used. After the carbon has been removed, a small percentage of manganese iron, rich in carbon, is added. Different elements may be used, and if they replace a certain amount of carbon, it does not seem to affect materially, the character of the product. I do not know that experimenters are agreed as to a little of this thing or that; at one time chrome steel was talked about, and I think in the St. Louis bridge chrome steel was specified, though you do not hear a word about it now. Experiments have also been made with aluminum.

THE PRESIDENT: Some effort has been made to ascertain the effect of nickel on steel?

PROF. GREENE: Nickel steel is now used for armor; I suppose nickel is introduced into armor for toughness, to prevent the hard steel plates from cracking. I do not understand that this quality is particularly desirable in structural material.

MR. WELLS: If Professor Greene would make some remarks upon the matter of sulphur and phosphorus in this connection I think it would be very interesting.

PROF. GREENE: Phosphorus is an ingredient which is very highly objectionable. It makes iron what is known as brittle at ordinary temperatures, and it is usually specified that the product shall not contain more than $\frac{1}{10}$ of one per cent of phosphorous, if I recollect the figures aright. A very trifling amount only would be tolerated, and those ores which contain much if

any phosphorus, it has not formerly been found possible to utilize in the Bessemer process, though means have since been devised, I believe, by which the phosphorus may be reduced, and such ores utilized.

Sulphur is deleterious to a certain extent. It make iron brittle when it is heated, and if iron contains much sulphur, it may crack when rolled or fly to pieces under the blacksmith's hammer. But if there is not enough sulphur to produce that effect, I do not understand that it is otherwise objectionable.

INDEXING FIELD NOTES.

Grand Rapids, Jan. 2, 1894.

To the Michigun Engineering Society:

GENTLEMEN—A few years ago it became necessary to rewrite our general index to field notes, as the old book was nearly worn out.

After making some inquiries as to the method of indexing notes in other cities, without hearing of a method which seemed satisfactory, the following plan was decided upon:

A large blank ledger was procured and one of "Graves' First Letter Indexes." The second book to serve as an index to the first. One page of the ledger or more, according to the importance of a street, was devoted to the notes referring to that street, and the name of the street was written at the top of the page. Thus you see an account, so to speak, was opened with each street. In the left-hand column was written the object of the notes, *i. e.*, "Level notes," "Sewer notes," "Survey," etc. In the central portion of the page was written the portion of the street to which the notes refer, as "A" St. to "B" St., and in the columns to the right the number of the field book and the page upon which the notes begin. The contents of each field book are also indexed on its first pages.

The practical working of this system of indexing notes has been so satisfactory that I am satisfied it can be extended so as

to make a complete and general index to everything in an engineer's office. I submit for your examination a couple of sample pages, showing how I would have them ruled for use in the office where I am employed.

The index book should be of the best quality of paper, and one of the methods for making it open flat should be employed in its construction. The headings could be printed or left to be written in as required. Care should be taken to leave ample room for each subject, and also to so subdivide general subjects that each list will be as small as possible. The subject of bridges could be subdivided into bridges on "D" street, "G" street, etc.; they would also be indexed under the head of the street upon which they occur.

I have found it convenient to index alleys under the title of the plat in which they occur, reserving for the general title of "alleys" only such as occur in unplatted land.

In addition to this general index, I would also keep a list of street profiles and a list of sewers, because they are called for so often that a smaller index will repay, in greater convenience, for the time in keeping it up.

It will be observed that this index could be extended to several volumes, by having one index to them all. Thus, we wish to find something about S. Division street; the small "First Letter Index," which we first consult, tells us that we will find S. Division street in Vol. III, p. 125. Upon which page we should find a complete index to everything in the office referring to S. Division.

If this suggestion helps to bring order out of the chaos existing in too many engineer's offices, it will have served its purpose.

Respectfully,

G. M. AMES.

S. DIVISION STREET.

Subject.	From.	To.	Book.	Page.	Cabinet.	Division or drawer.	Shelf or compartment.	Number of drawing.	Width of St.	Width of walk.	Length of St.	Date of adoption. Year.	Month.	Day.	Remarks.
Sewer levels	Cherry St.	Wealthy Ave.	*a*	30	*C*	1	*a*	----	----	----	----	----	----	----	
Plan for imp.	Fulton St.	Island St.	1	20	*B*	3	----	----	66	12	300	1868	May	20	
Level notes	Maple St.	Goodrich	*c*	27	*C*	1	*a*	----	66	12	----	----	----	----	
Survey	Fifth Ave.	Hall St.	1*a*	35	*C*	1	*a*	----	----	----	----	----	----	----	
Profile of	First Ave.	Fourth Ave.	2*c*	89	*C*	2	*B*	----	----	----	----	----	----	----	
Diagram of extra work on sewer	Maple St.	Wealthy	----	----	*A*	1	*A*	37	----	----	----	----	----	----	
Culvert plans	Over Silver Brook	----	----	----	*B*	1	*C*	300	----	----	----	1891	June	1	

BRIDGES.

Subjects.	Book.	Page.	Cabinet.	Division or drawer.	Shelf or compartment.	Number of drawing.	Date of adoption. Year.	Month.	Day.	Remarks.
Floors, general plan for, when street car tracks exist	----	----	*A*	1	*B*	63	----	----	----	
Plan, for bridge on S. Front street	----	----	*A*	1	*A*	26	----	----	----	
Abutment plan for bridge, at E. end of Bridge St. bridge	----	----	*A*	1	*C*	20	----	----	----	
Pencil sketch of same	----	----	*B*	1	*G*	240	----	----	----	
Plan of approach to W. end of Bridge St. bridge	----	----	*A*	1	*A*	22	----	----	----	
Details of bridge, submitted by Queen City Bridge Co.	----	----	*A*	1	*A*	38	----	----	----	
Plans of bridge at Bridge St., built by Morse Bridge Co.	----	----	*A*	1	*C*	27	----	----	----	
Profile of Grand river at Bridge street bridge	----	----	*A*	1	*A*	50	----	----	----	
Lateral bracing (proposed for Bridge street bridge	----	----	*A*	1	*A*	48	----	----	----	
Lateral shoe street for Bridge street bridge, by E. W. Eckert	----	----	*A*	1	*B*	13	----	----	----	Constructed by Massillon Bridge Co.

LUMBERING IN NORTHERN MICHIGAN.

F. S. DEWEY.

To one who has spent the best part of a life-time among the pines of northern Michigan, who has traveled for weeks or even months at a stretch among their interminable depths, has seen the rivers season after season filled and refilled for scores of miles with floating logs, has seen them converted by those voracious monsters, the hungry mills, into lumber, and borne by the numerous fleet of ships to the various distributing points, a description of lumbering in Michigan would be extremely trite. To such a one this delineation can possess very little interest.

As the little pudgy contrivance called a sled while bobbing along with two or three logs over the yielding corrugated serpentine rabbit track of a road as beautifully illustrated along the southern borders of Michigan furnishes a very high order of amusement to the northern lumberman, so there may be a sort of reciprocal interest in the outfit of the north.

The type of northern lumberman is a symbol of progression. He is an inventive genius, never stands still, is always on the alert, would unhesitatingly throw his whole outfit into the river, saw-mill and all, if he thought he could see a dollar in the sacrifice. Every year sees the birth of improvements somewhere along the line. Whoever would stand still must get out of line or be run over. There is scarcely a business which calls for a better exercise of the judgment than this. From the purchase of the standing trees to the sale of the last plank, there must be the same careful hand that suceessfully manipulates the destinies of the chess board. Mistakes are dangerous. A single hill on the road has dissipated a fortune, and low water in the rivers has left the bleaching skeletons of many fond hopes along their pebbly beds, while the winds in the swaying arms of the ghostly overhanging hemlocks sung a mournful requiem. The rivers are

now dammed, substituting for the expletives and emphasis of earlier days the more substantial timbers and earth by which means vast reservoirs are locked up until their forces are called into requisition.

Some of the features of the business being peculiar to the north may be worthy of special attention. The camp may be considered one of these features. This, for obvious reasons, must be located near some abundant supply of good water, and should be conveniently near the middle of the tract to be lumbered. If the camp is to accommodate seventy-five to a hundred men, it has quite the appearance of a hamlet in the woods. The various buildings except the stable are always called shanties, although some of them are of necessity very large. They are always built of logs chinked with moss or clay, roofed with boards, and tarred felt, and all suitably provided with valve ventilating flues extending up through the roof. In camps so built no one ever complains of the cold. Even in the stable, water rarely or never freezes, and yet every horse is provided with a blanket, just the same as is every man. It's safer. It's economy, and takes less feed, as well for the horses as for the men. The food is directed as much as possible to the muscles, while the blankets and the huge stove look to the warmth.

The camp is built and the cutting and skidding of timber are begun early in the fall, so that by New Years there is generally little left to do but haul the logs to the landing on the banks of the nearest floatable stream.

A visit to the men's shanty, especially in the evening, is full of interest. It is a long, low building, with two or three little square windows, a large box stove near the center, on which is the omnipresent huge iron tank of hot water, a long sink with outside drainage, and plenty of tin wash dishes and towels, combs and looking glasses. Here also are the two great water tanks, one above the other, the upper one for drinking water, and provided with a faucet, the lower one to receive its waste and to furnish wash water. Here, too, are the grindstones to receive the nightly visit of every ax, while the saws, the cant-hooks, the whetstones and all the individual accessories of the camp are ranged in their regular order.

Skirting the walls of this camp, on three sides, are the long rows of bunks, three or four tiers high, each bunk provided with plenty of marsh hay or straw, a bag full for a pillow, and three good, heavy, gray double blankets, which lull the tired woodsman into perfect slumber. In front of the lower berths, extending around the room, is the "deacon's seat," on which long yarns are spun. Here, too, the musicians peal forth their wild and weird strains while the dancers, like Tam O'Shanter's witches, go wheeling and tearing up and down the floor.

On numberless wires, strung like clothes lines high above the stove, and hanging like vampires in their sleep, are endless mitts, and socks, and shoes, packs and other highly odoriferous things, whose tangible aroma offers no reminder of a peach orchard in bloom.

The visitor who ventures a night in this hospitable shanty needs no stronger hint to pull the moss from between the logs and place his hose to the bracing draught. No sooner do his eyes begin to grow heavy than, from a multitude of invisible teachers, he learns why the invitation to stay has been so hearty. The omnipresent gray-back is no respecter of person, and he roams up and down the fresh anatomy like Buffalo Bill's wild coursers on Midway. It is said that no well regulated camp is ever found without them.

At nine o'clock all lamps are out, and stillness reigns till half past four, when the chore boy shakes each teamster into life, and half an hour later the general shout, "breakfast! breakfast!" rouses all. In a long line, by the light of the stars, the motley crew march to the cook's shanty, where long tables with strong benches furnish plenty of room for all. Nowhere on the face of the earth can one find better cooking, nowhere greater variety or better meals. No Sunday school picnic table in the woods ever groaned under a heavier or more luscious load. Great steaming pans of tempting, dark-brown pork and beans, that have been buried in hot coals in the bean hole since the day before; basins full of tender corned beef, others with dried apple sauce, seasoned as one finds it nowhere else, prunes, pies and pastry in endless variety, potatoes, turnips, and always an abundance of excellent bread and butter and tea; indeed, every-

thing that working men could possibly need or want to make them strong is furnished without stint in every camp.

So abundant is the food, so great is the variety and so active the occupation, that a healthier, happier, stronger lot of men could hardly be found.

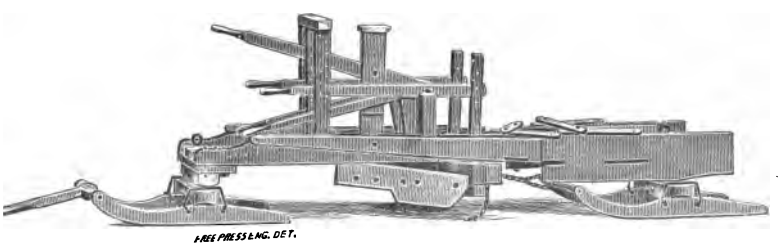
The foreman is the *boss*. He is the Czar; any lazy, disobedient or disturbing spirit receives his "time" and takes the "tote road" at once.

Tobacco, and all kinds of men's wearing apparel are kept in the "office," a small separate building, and are sold at fair prices to the men. The wages range from about sixteen to twenty-six dollars a month, the choppers, sawyers, teamsters and cant-hook men getting the higher figure, while swampers and roadmakers get the lower. The pay is always cash on presentation of the "time" at the place where hired.

The location and laying out of the various roads, and especially the main road to the landing, is of the very highest importance. Here the skill of the practised engineer is especially called into requisition. A half a mile of detour had better be added than to take the risk of any considerable up grade. A down grade, even if too steep to be allowed in any public highway, offers but little obstacle. The section man, always on hand, applies judiciously and bilaterally a little sand, or what is far better, a sprinkling of marsh hay, more or less as the sun rides lower or higher, and the immense loads go slowly and safely down. Up grades of more than one per cent are rarely found in first class log roads, unless immediately preceded by a good, sharp descent for momentum to carry the load over. The road-bed is prepared almost as if for a railroad and always before the ground is frozen. Swamps and marshes and lowlands along the streams are sought rather than avoided along the line of the road. Brooks, creeks, ponds and little lakes are the sources of water supply, without which successful logging on runners would be impossible. As many pools as possible are provided by digging in the swamps, damming up the creeks or skirting the little ponds or lakes, and as soon as the snow plow has formed the track in the first permanent snow, the water tank is put to work. This is a huge plank box, thoroughly rodded and braced, loaded on a sleigh, and having a

capacity of from sixty to a hundred barrels. In the center is a strong post extending about six feet above the top of the box and provided at the top with a pulley or sheave through which passes a rope, to which is attached the bucket for filling the tank. This bucket is usually an oil barrel, having a strong bail by which it is nearly balanced at its middle, and properly weighted it easily fills and empties itself. A sliding way from the post to the top of the box directs its movements and a smart pair of horses at the other end of the rope soon learn to fill the tank in from eight to twelve minutes. Once on the road and at the proper place, the "tank trailer" pulls the two plugs at the bottom of the rear corners and two great streams two inches to two and a half in diameter shoot out behind and fairly deluge the road. The team meanwhile may, by a brisk walk, cover from quarter to half a mile before the water is spent. All night long and all winter long, by the light of the lantern, the moon and the stars, when the road is clear of all other teams, this work of building and maintaining a road of solid ice is carried on.

Always in connection with the water tank the snow plow or more properly ice plow is used. One form of this is shown in



the accompanying cut. It is a heavy framework mounted on an ordinary sleigh and having foldable wings which may be opened or closed by levers or set at any width and having also an A shaped plow movable up and down by three levers also. This has sharp steel knives or shares that will cut the hardest ice making the road perfectly even, inclining for curves and as smooth as the glassy surface of a forest pond. A solid comb is formed in the center and strong shoulders at each side so that under no circumstances can the sleigh ever get out of the track.

A cross section of the road is about as shown in the accompanying cut, the two low depressions being the tracks for the

runners. The sleigh used is invariably similar to the one shown with the snow plow above. The length of the bearing surface of each runner is about seven feet; the shoe of steel is about half an inch thick and four inches wide giving the whole sleigh a bearing surface of over nine square feet. The single beam for each pair of runners is usually about eight inches deep, fourteen inches wide and six feet long and is very loosely fastened to the runner by the rave passing over it as shown, and a vertical inch and a quarter iron pin on each side fitted loosely in a semi-cylindrical grove and all so loosely connected that one runner may be pulled forward or one end of it lifted up as much as a foot without in the least disturbing its mate. Indeed it is such a ram-shackle contrivance that, on first introduction, one almost expects to see the thing fall to pieces without any load at all, and yet on the top of this loose-jointed affair are placed swinging bunks from ten to fourteen feet in length and on these are rolled up the huge loads of logs, often sixteen feet in width and nearly as high as wide. When in the gray dawn of the morning one sees the long line of loads leaving for the landing one almost imagines he sees a village marching away.

These loads are simply enormous. The weight of them is almost beyond belief. Green pine logs weigh fully nine thousand pounds per thousand feet and yet it is no uncommon thing for loads to average, for all winter, from six thousand to seven thousand feet each, or from fifty-four thousand to sixty-three thousand pounds per load; and yet enormous as they are, with this rigging and on such a road, they are always easily handled by a single team. The adaptability of this sleigh for business may be better understood when it is known that its entire weight—sleigh, bunks, chains, binder, driver and all—weigh less than five per cent of the load which is safely carried.

What would become of one of those little stiff and frozen things of southern Michigan called a sleigh if placed beneath one of these loads? Even a half dozen of them together would meet the fate of the "one hoss shay" at the first move. Not only is this build of sleigh used for logging purposes, but the single beam, loose-jointed type is followed for every business vehicle on runners, light or heavy, throughout the northern half of Michigan.

For felling the trees and cutting them into logs the men go in gangs of five: Two choppers, two sawyers and one swamper. The head chopper or "notcher" casts his practiced eye up the tree and then along the ground to determine where it may be made to fall without breaking it in pieces. The novice would ruin many valuable logs. The whole tree should if possible strike the ground its entire length at once. A notch is cut a few inches in depth on the side toward which it is decided it must fall while the saw from the opposite side does nearly the entire severing from the stump. Several thin, wide wedges driven into the saw-cut force the tree to fall as planned. Occasionally these monsters of the forest are so perfectly balanced that it is with great difficulty that they are forced from their stable equilibrium even after having been severed entirely from the stump. The two sawyers make the tree up into logs the swamper trimming and clearing the way.

As crashing trees and flying limbs are not particularly enchanting the skidding crew follows always at a very respectful distance. Before every "fall" the choppers familiar, long-drawn yell re-echoes through the forest its note of warning which nobody ever learned to spell but which commands the profoundest respect of every man in the woods. The skidding is simply the hauling or stacking together of the logs and putting them in large, convenient piles on skids well up from the ground along the various branch roads which lead all through the works. In loading on the sleigh the first half dozen logs or more are put on by hand with cant-hooks but the topping out generally by team with pulley and line. The landing, as the name implies, is simply the bank of the river or stream down which the logs are to be floated to the mills. As the spring floods come the landings are broken and the "drive"

begins. If the stream is straight and good and deep the drive is easy, but if otherwise, jams occur and the logs go scurrying over the meadows or off into the wood, and the poor river driver up to his knees or even up to his waist often in the icy flood sees very little in his wild rebellious flock to lull him into poetic reverie. The logs having been brought out of the small streams beyond the danger of low water and well nigh their destination are generally taken in hand by the "boom company" a regularly organized stock company generally of mill owners and log owners whose business it is to sort, handle and deliver logs to the various mills as they are wanted for sawing. To cover the expense of this work an assessment is fixed and levied on the logs at so much per thousand, and a scaler is placed in each mill by the company, who measures every log before it reaches the saw. In order to maintain perfect fairness these scalers are shifted two or three times a month to remove them as far as possible from undue influences. In spite of all this precaution however, certain yards often show a season's measurement thirty or forty per cent above the boom company's scale. When shipped the lumber is usually carefully inspected piece by piece as it leaves the pile and is properly graded or classed, the price for inspection being generally from fifteen to twenty-five cents per thousand feet, one-half being paid by each party to the trade.

Of late years the river driving has been largely superseded by railroad transportation, the logs being banked by the track instead of by floatable streams.

The business in Michigan has for many years been simply enormous. With fairly judicious management mistakes and losses were extremely rare. Whoever possessed any considerable amount of stumpage had what was better and far surer than a gold mine, and it is very doubtful if any other business has ever yielded such sure, quick and ample fortunes.

MR. TEED: I have seen large things in the woods, but I never saw anything like that load of logs at the World's Fair.

MR. HODGMAN: I would like to hear the yell.

MR. TEED: I remember once I was coming through the woods and the snow was very deep. I had an instrument on my back. The snow was so high that it was almost impossible

to get along, except in the track. I heard some men sawing on a log, and couldn't locate exactly where they were. By and by the yell came, what to do I didn't know. I didn't know whether the path would help me and I couldn't run in any other direction; I concluded my instrument could better take the chances than myself, and I left it and took to my heels.

METHODS IN IRRIGATION.

Gentlemen of the Michigan Engineering Society:

I gave you last winter a brief paper on southern California and one of its irrigating systems, and at the earnest request of your worthy secretary will give you a very short paper on how the water is distributed on the land. There are two methods, the furrow and basin systems and all methods are either one or the other or a modification of them.

The original practice appears to have been to run the water on to the land from the main ditch at frequent intervals through an opening cut in the bank into a furrow, and this furrow broken here and there, and the water allowed to run and spread over the land as best it might, being directed as well as might be by a man or two who with shovels cut a little here, banked a little there and so got the ground all wet or as nearly so as might be.

This system has passed through various modifications until it is now seen in its perfection at Riverside and other localities where a head ditch or better a redwood or cement flume of proper size is built across the upper end of the tract. In the side of this flume are holes covered by a little slide of zinc that will remain in any position.

The Riverside irrigator now furrows his land in narrow furrows with a proper cultivator, the furrows small and even and running down the slope. At the head of each furrow is one of the small openings in the flume, through which the desired amount of water is let into the furrow. The amount can be nicely adjusted so that by the time the water has reached a certain place in the head flume it is all used, and a miniature

stream is flowing down each furrow, which is let run until the water has reached the lower end of the field and all is watered.

The furrow system is the one that must be used almost exclusively among growing crops in rows such as corn, cane, berries, vines, etc., except where the ground is almost a dead level then the basin system or a modification of it may be used with advantage when water is plenty and cheap. When the slope is too steep for straight furrows they may be carried back and forth in zig-zag lines to secure a sufficiently slight slope to prevent serious washing. Terraces may be successfully watered in this way, by providing suitable drops from one to another. The advantage of the furrow system is its cheapness and ease of appliance. You regulate the water and let it run night and day till done. The disadvantage is that the upper portion of the field receives much more water than the lower, and it is impossible it should be otherwise, still some localities can see no utility or beauty in any other system.

The basin method too has been developed from a very primitive way of irrigating. At first some ground was too sloping and the water turned on it from the furrow would run off too quickly or leave places not wet at all, to prevent this the ground was laid out in blocks with a plow and ridges thrown up by the furrows between them, and the water allowed to run into each block and stand till it settled away into the ground, following up this method has been developed the perfect basin system.

Take for instance an orchard, furrows or ridges are made on each side of a tree at the required distance away, depending on the size of the tree and the area necessary to wet, for trees one year old a distance of three feet is all that is necessary, and the intermediate ground need not be wet unless for other purposes than for the tree. As the tree grows older and larger, larger basins are needed until finally the ridges are midway between the trees and the entire ground is flooded with the required amount of water. When this is done a main distributing furrow is made between every other row, and each basin filled in rotation down one side and up the other, then the water turned into the next main and so on. When the basins are small a furrow is run alongside each row and every other basin filled going down, the others coming back or the water is

followed down and the lower basin filled first and each in turn to the upper end and the process repeated with each row. In this way each tree and each basin can receive the proper amount of water and only such portions watered as may be necessary, and is a great deal more economical method than the furrow. The basins are very easily and quickly made with a V or crowder which is made of plank and almost exactly like a small snow plow such as you clean the snow from the walks with in winter, except it is open 10 or 12 inches at the narrow end and goes like a crab, backward. In connection with the crowder a jumper is used, which is like a shovel plow with a wide light blade and is used to fill the corners of the basin, and a man and team will go over and prepare several acres in a day so as to need very little hand work to complete them.

Since writing the above I have been down in Sonora, Old Mexico, and find there in places the basin system used when the supply is wholly from the rainfall catchment, quite extensive fields are enclosed by dikes three feet high and the channels of storm water turned into these large basins and held until it soaks away. In this manner an irrigation is sometimes secured that will carry over to the second season and secure good crops with no rainfall. To the uninitiated the artificial watering of land seems quite a task, but when the methods are understood and the proper appliances are at hand it is very much superior in a great many ways to depending on rainfall. The time at my disposal will not allow a further amplification of the details but I think you will have no difficulty in understanding something of the methods used in practical work.

THE PRESIDENT: It has always seemed to me that the time is coming when in all this country, it will be necessary to resort, more or less, to irrigation, and I am inclined to think, that if our farmers would go to work and put in waterworks, tanks, etc., to supply water to irrigate their farms, they would pay for a plant in two year's time, in the amount they would save.

MR. APPLETON: Many a man with a hill, could plan a reservoir there.

THE PRESIDENT: And these tanks can be gotten very cheap. One very dry season ruins a crop. I saw at the World's Fair,

in the Agricultural Department, an exhibit of potatoes from Idaho, where they have scarcely any rainfall and the statement was made that they raised 974 bushels to the acre. One crop of that kind would pay for the cost of the apparatus for irrigation. I saw one pumpkin that a man could crawl into.

MR. COATS: I met a man in North Carolina who claims to have raised 1,100 bushels to an acre.

REMARK: That was in North Carolina.

MR. STRONG: Kalamazoo is known as the celery town in this State. The bulk of this product comes from the north of Kalamazoo. The first man who went in there, bought ten acres, on a brook, quite a stream, and the bottom was quite deep, and his plan in going down there and buying that and paying a foolish price for it (quoting his words), was to dam up that stream and cut ditches, and whenever he wanted to, dam the stream and irrigate from the bottom.

This same man had a few acres of splendid land, well irrigated, and instead of harvesting his cabbages, he gave them away and attended to his celery, irrigating from the bottom, and never from the top again. That same thing is carried on to a considerable extent where it can be done, all over Kalamazoo county.

THE PRESIDENT: Did this man lay a tile drain?

MR. STRONG: The bottom of the ditch where the stream ran, was about three or four feet from the surface, but he put in a dam to raise it. He has put in a system of loose tile, starting from the ditch, and having everything covered. When he raises the water, it passes through all these little pipes. He lays this tile from the stream back.

THE PRESIDENT: That was what I was asking. Whether he let the water soak through the ground, or if he put these tiles in so it could work all through.

MR. STRONG: He first cut lateral ditches, sixteen inches from the bottom, and the water was way below. When he wanted any, he would shut down the gate to send the water up the laterals. That it seems, was not satisfactory, so he put in tiles, loose, and covered them up, so his field is an unbroken surface, but you go along the ditch and you will see these tiles sticking out. He probably raises the finest celery in Kalamazoo.

MR. HODGMAN: This plan of irrigating simply by raising the water in the ditch, works only in that particular kind of soil. I have been informed that in California, where surface irrigation is used, sooner or later, they are obliged to lay tiled drain. The ground water gradually rises to such a height that a double system becomes necessary, a system of surface irrigation, and tiled drainage. Following that, has come this practice of using tiled drains for irrigating purposes.

MR. ALBERTSON: In dry time they run the water off, and in wet time, they run the water in these tiles.

THE PRESIDENT: In some places they lay a system of tiles, under loam or loose soil; the sewage from some establishment is carried into that and distributed all over the ground-works through the joints, becoming sub-irrigation.

RECLAMATION OF SWAMP LANDS.

BY O. H. TODD.

The swamps of Michigan were for many years regarded as a useless and dangerous encumbrance, the breeding place of deadly reptiles and not less deadly malaria. Within their borders lurked the rattlesnake, the wildcat and the panther, and in their almost inaccessible recesses, the counterfeiter and horse thief found concealment.

The productiveness of the virgin soil of the easily cultivated uplands left little inducement to the first settlers to undertake the laborious task of reclamation of swamps, and wherever any attempt was made the almost universal result was failure—failure from a lack of knowledge of the task undertaken and the proper course to be pursued to win success.

In the present article, I will endeavor to give the result of my experience and observation.

When entering upon the undertaking of reclaiming a swamp or marsh, the first thing to be considered is a proper system of drainage. No rigid rule can be given that will fit all cases and occasions, and the engineer in charge of the work should

possess cool discretion and common sense in addition to a knowledge of mathematics.

If the tract to be drained is flooded by the overflow of a lake lying higher, then, usually, the straightening and enlarging of the natural outlet of the lake—with an equalization of the fall the entire distance, when practicable, will be all that will be necessary for the main drain. Lateral drains should be run into the main drain at not more than eighty rods apart. This distance must be varied according to the circumstances. Black Ash swamp needs fewer and less expensive lateral drains than tamarack or soft open marsh.

Two things should always be borne in mind: First, drainage is for the purpose of getting rid of superfluous water; second, irrigation of the swamp is often as important a matter as its drainage.

In construction of the main drain, the banks should be cut at a slope of 1 to 1 or 45°. A careful estimate should be made of the capacity necessary to carry the usual flood water of spring —the drain being wide rather than deep. The surface of the water in the drain should never be more than two feet below the surface of the swamp. This is an important matter for it is essential that enough water be retained in the soil to promote the growth of vegetation.

When the land surrounding the swamp or marsh is springy, it is well to run a "belt-line" ditch near the line of the upland and marsh and extending from near the head of the marsh to the lower end with numerous laterals to the main drain. Springs occurring in the swamp or marsh should be conducted through tile to the main drain. These springs are often of great value for purposes of irrigation in August or September. Gates should be constructed in all the ditches to control the water in dry weather.

It often happens that obstructions are met with which forbid the construction of a drain in the usual manner. At the foot of the lake and head of the swamp, the remains of ancient beaver dams are often found. These are generally filled with quicksand and can usually be overcome by planking the sides of the drain. The plank are held in place by 2 x 4's driven deep into the ground inside the plank, and stayed by a cross

piece of the same material on top—the cross piece extending, of course, across the drain. Sometimes it is advisable to tile across sand bars, but in that case, unless there is considerable clay mixed with the sand, it is well to lay the tile on plank laid in the bottom of the drain.

Occasionally we find quicksand of such an obstinate nature that it can be neither tiled nor planked to the depth we wish to lay the drain. Several instances of that kind have occurred in our (St. Joseph) county. Little Portage drain is located in town 5 S., range 10 W. Its upper end is the outlet of a lake. I attempted to make a short cut from the upper end of the old outlet at the lake due west about eighty rods to again intersect the course of the natural outlet. This straightening passed through a gravelly soil underlaid with the worst of quicksand. I found it impossible to reduce the elevation of the quicksand, as it boiled in from the bottom of the excavation faster than ten men could throw it out with shovels. After expending considerable time and labor, I gave it up and taking the meandering line of the natural outlet, the bed of which was composed of a deposit of clay mixed with a small quantity of sand and gravel, I found no trouble in constructing the drain. This course was about a mile long, whereas the direct distance was only eighty rods.

The lake was lowered 3½ feet and in three year's time I found no difficulty in constructing an open drain. The drain was reconstructed upon the direct line—the lowering of the water level having caused the sand to lose its "quickness."

Another way to overcome quicksand is to drain gradually cutting deeper each year during the dry season till the desired depth is reached.

The success of any attempt to drain swamps adjacent to large streams or lakes and that are subject to overflow from them would, of course, largely depend upon the construction and maintenance of levees.

After having thoroughly drained the swamp, the next step in the process of reclamation is to remove all trees, bushes, stumps, etc. This is often best accomplished by burning over as soon as the autumnal rains have wet the ground sufficiently to prevent the muck taking fire. Having been burned over for three successive years, but little timber will remain. Of course, if

the land is needed for immediate use, the above slow, but cheap method of clearing can not be resorted to. In most cases the wood will pay the cost of clearing off.

Next, we must properly plow the ground. Right here is where a majority of the failures are made. It is no easy task to subdue the luxuriant vegetation or the marvelous toughness of the sod growing in these low lands. The furrow is usually so soft that it is necessary to use a mud-shoe fastened to the bottom of the horse's foot by clamps over the hoof. They are sometimes made of wood, but the best are of malleable iron, and are manufactured at Decatur, Michigan.

Much trouble has been experienced in procuring a plow suitable for marsh or swamp lands. The various large plow manufacturers make a steel shear to attach to their upland steel or chilled plows, and recommend the combination for marsh work. They are very unsatisfactory, however, as they are unable to turn the furrow flat, but leave it set on edge allowing the grass to grow between the furrows causing a great amount of work to keep clean the crop planted.

The only plow I ever saw that could do good work in all varieties of marsh or swamp is an "all steel" marsh plow made by John Deere of Moline, Illinois. This plow cuts from twenty-five to twenty-eight inches wide, and from four inches to twelve inches deep, turning the furrow perfectly flat. Its weight is about 400 lbs. and four horses are required to draw it.

After plowing, the disk harrow (nothing else will do) must be put on. There are many good harrows of this kind produced by various firms, but "The Warrior" made in Chicago is as good as any. In using this implement, the operator must have sense enough to properly manipulate the levers or he will do but little good. It is of heavy draft and should have three or four horses attached. It sometimes is required to go over the land ten or fifteen times with the disk before it is thoroughly pulverized. It will be observed that the plowing and pulverizing is a costly and tedious process, but it must be well and thoroughly done or all the previous expenditures are wasted.

The ground is now ready for planting. We have a soil of exceeding richness, and if planted with a crop adapted to low lands will yield wonderful returns.

Peppermint is perhaps the best crop and if carefully cultivated, and of the "Michem" or English variety will yield from forty to sixty pounds of oil per acre—the oil being worth at present $2.35 per lb.

If the peppermint is kept free of grass the first year, no further cultivation will be necessary for four or five years, but the crop can be cut annually. Common red clover will grow well, yielding twice as much seed as on upland. If the drainage is thorough, corn, potatoes, cabbage, and every variety of root crop yield abundantly.

Of course, this is the only kind of land suitable for celery. Timothy will not always grow well, until after the land has been cultivated a few years.

We have followed the process of reclamation from the initial step of drainage to the final victory of a harvest. It is a mistaken idea to suppose that the drainage of a swamp includes all that is necessary in its reclamation. The process is long and laborious, passing through various stages of development, and at every step is needed a thoughtful, careful man who is not afraid to labor.

MR. COATS: I was specially interested last summer in investigating quite a prominent ditch about three miles north of St. Johns. It was perhaps two or three miles long; made to drain an extensive tract of swamp lands; the fall is very slight. That ditch is pretty deep most of the way, I should think it would average eight feet, and it was through a black muck all the way down. I should think it was about four feet wide on the bottom and when I investigated it, in the latter part of the summer, it was dry, with but little water passing through. I was surprised to see how the slopes of that ditch had stood. The slope was not more than one-half to one, and there was scarcely a foot of the whole distance that I investigated, two miles, that showed any serious movement or disturbance, and the ground, which originally—before the ditch was made—was undoubtedly all water and mush, for several feet down, was mere dust. That would bring in the point of the necessity for irrigation in such ground at certain times of the year.

There is one other point he mentions, that always amuses me—the bug-bear people make of the treatment of quicksand.

For myself, in my own experience, I would rather encounter quicksand than many other difficulties.

Mr. Coats here described cases where he had sunk wells in quicksand by the use of caissons and his method of sheet piling.

MR. ROGERS: I am at a loss to know yet how you are going to keep the quicksand out of the open ditch. He speaks of a tile there.

MR. COATS: I think he spoke of tile there; in an open ditch, you can't.

MR. STRONG: If you can get a stream of water passing over quicksand, it will go out.

Mr. Todd is a brother of Mr. A. M. Todd, who is known as "The Peppermint king" in the southern part of Kalamazoo county, and it is interesting to note what he has been compelled to do in the way of draining. It is necessary for him to lay the drains so they will be half full of water; the same is true when you drain for celery. In that portion of Kalamazoo county where celery raising first began, they always had the best success with their crops because they couldn't drain low enough but what the surface of the water stood within eighteen inches or two feet of the surface of the ground.

MR. APPLETON: We often have a line cut through inequalities, where one is obliged to cut a good many feet down, and it is often difficult to lay tile in these places. Sometimes there is a sort of an inland sea, and just as quick as you get the water away, there is peat; I have put pipe seven feet deep and not found the bottom of this peat.

I would like, if possible, to put drain tile below the peat, but I have found places where it was impossible to do so, and then have recommended the proprietor to make open ditches. The question is, how can you put in a tile?

MR COATS: Put in a layer of gravel.

MR. APPLETON: Couldn't stand the expense.

MR. COATS: You want to cover the tile up.

MR. APPLETON: Certainly; but here you would have to do your carting over stuff that wouldn't carry a horse, or you, or your instrument; the least pressure one way or the other would carry you over.

MR. ROGERS: I once located a ditch which started at Black River and ran half a mile over clay flats, and then through quicksand and entered a swamp, which lay about twenty feet above Black River; it was necessary to cut about six feet deep, through the quicksand, and after it had been working a year or two—after the completion of the ditch—I found that the mucky soil it passed through was utterly dried out and that it was practically good for nothing.

MR. HODGMAN: I have noticed the same thing, and I think that is a good point to emphasize; you can drain muck too thoroughly. I have seen a good many pieces of mucky swamp drained so dry that they were practically worthless.

A great share of our drains, for a good many years to come, will be open drains; I have been in the habit of laying out drains with slopes of one to one; not for everything—for there are certain classes of soil where that angle is too steep. In a mucky soil, I never saw a ditch yet but that it came to take something such a form as this (U). Now why isn't that a good form to dig it in the first place, for any ditch I ever saw, dug in muck, will, within two years, take about this form. It will not stand at 45 degrees.

MR. APPLETON: Isn't the next move, to take a piece off the upper corners?

MR. ROGERS: No, the turf helps to hold it.

MR. HODGMAN: The draining of quicksand can be done with open ditches. I said that it could be done by taking the water out; but I would speak of a particular piece, a drain near my residence that goes through quicksand about forty rods, and drains a lake; it was first opened twenty-three years ago. It was impossible to reach the full depth at that time, on account of the quicksand there was in the bottom; the quicksand boiled right up. After that ditch had been there a while, the water got out of the quicksand and it was lowered three feet more; it has been lowered subsequently, until it is ten feet deep; part of it in sand and gravel. You take the pressure of the water off, so it will not force the quicksand up, that settles the whole matter. After you get the water out of the quicksand, it is like any other sand.

MR. ROGERS: Speaking of the action of quicksand, after it is drained; in the summer of 1890, a brick sewer was built, along Tenth avenue, of my city, in quicksand. A sewer was dug a year later striking this at right angles, the brick sewer was about twenty feet deep and the joints were not tight. It served to a certain extent as a tile drain; it was made as well as it could be made, in that soil at that time, and in the locality where this sewer was built, before the construction of the brick sewer, it was almost impossible to carry away the water; after this had been constructed one year, the lateral sewer was built 900 feet long, emptying into this brick sewer, and the banks stood perfectly and we never saw a drop of water, at a distance of 900 feet from the sewer.

MR. SEARS: I do not know of anything more important than draining swamps, here in Michigan.

MR. APPLETON: And it involves deeper problems than we realize. All of these questions of engineering come up.

MR. STRONG: There are a great many side drains in after years to come in, and an engineer must take all these things into consideration; must know his country, and about what drains will afterwards be needed. I remember one drain that was laid out, where I was criticised for draining one section too much; I said to the person interested, "Do you suppose I laid that drain to accommodate you, I put that there to accommodate the drains that are to be laid through the country," and as Mr. Todd has suggested, they should endeavor to obtain water, not too far from the surface; now Mr. Todd does not claim to treat the subject of the ground drain, but simply for the benefit of the land itself, the reclamation of land, not the draining of the country.

There is another thing about draining land; I never saw a ditch yet that after a few years was any too large.

I think Mr. Hodgman's suggestion was good; the question was, whether it was not a good plan to round the bottom. As the stream of water becomes small, if it is rounded, it will hold it in its place,—with a wide bottom, it will make a crooked water-course.

MR. HODGMAN: It is always my point to endeavor to make the bottom of the ditch just wide enough so that the water will carry off all the obstructions.

MR. APPLETON: I guess that is the meat in the kernel; that is all there is to it.

MR. HODGMAN: That has been my endeavor; but in certain classes of soils would it not be policy in digging ditches, instead of making them so wide on top and narrow on the bottom, to begin with, to make them not so wide on top—more nearly perpendicular? It is a question whether if, after all, I have not been making a mistake, not to have dug them narrower on top, with a steeper slope.

MR. APPLETON: In the muck where there is a good heavy turf of sod.

MR. HODGMAN: In our part of the country, with some exceptions where nothing will grow, in a mucky soil, the Kentucky blue grass comes in of itself without seeding and makes a sod so that it will hold the bank from falling in.

MR. APPLETON: Just answer this for my information: When you have this over-drainage, which I have seen for some time, doesn't the soil finally get down together and rot and shrink up, so that after a while it begins to be good land?

MR. HODGMAN: I presume it will, after a while.

MR. SKEELS: Today we are reclaiming.

Run a series of tile, 18 inches deep perhaps, over the surface of the ground, 25 feet apart, and it will afford irrigation enough to make those dry muck beds raise vegetation; the air passing into those pipes will condense the moisture.

Then, why not make your drain ornamental as well as useful by sodding it right across, so that you can mow it, put turf all the way across?

MR. APPLETON: Why not make the slope so gradual that you can in dry time let a team go right across? It will avoid the expense of making bridges every once in a while.

MR. HODGMAN: There is a drain, within three miles of my house, that in high water carries a stream as big as the Grand river here at Jackson is now, and a portion of the drain has been built in just that way, by scraping out a broad surface. But in summer and low water the channel is blocked up to such an extent by the growth of vegetation in the ditch that the water cannot run freely.

MR. STRONG: There is one suggestion that might perhaps help sometimes when you are working in deep muck.

The insane asylum people laid about three miles of tile in deep muck; they took six-inch plank and laid the tile on it, and so far as I have heard it works all right. The boards, ordinary pine, are supposed to remain sound a great length of time. It is not so expensive as to draw on sand.

MR. SEARS: At one point I found muck 24 feet deep. I excavated a trench 24 feet wide, and filled in with clean gravel three feet deep, and built a solid stone culvert on this bed of gravel and covered it with seven feet of earth, just as an experiment, without a board. Below that is 16 feet of muck. About four inches of settlement came in that wall.

MR. STRONG: One advantage where the tile are not too large is that with this board system you can lay the tile rapidly and securely; each joint is as perfect as any other joint.

MR. HODGMAN: It is a question in my mind as to whether it is a fact that boards laid on the bottom of the ditch, to put tile on, do make a permanent foundation. Most authorities say that boards are a very poor foundation, from the fact that they decay, and not uniformly, and the tile will settle, making a bad job of it.

MR. SEARS: I know a place 35 years old where it is as good as if laid yesterday. If only they are always wet they will last indefinitely.

MR. HODGMAN: Wood decays, in my experience, a great deal faster if it is alternately wet and dry.

MR. WELLS: In examining some timber taken from a sewer built 40 years ago, it was found just as fresh as timber just cut down in the woods.

MR. HODGMAN: Timbers are apt to be wet at times and dry at times, and that is especially true of boards laid under tile in a muck soil that is not fed by springs. In such a case they would decay rapidly.

USE OF ICE BORING MACHINES FOR RIVER SURVEYS.

JOSEPH RIPLEY.

The United States has improved the navigation of the St. Mary's river by building new locks, deepening and enlarging the St. Mary's Falls canal, and by dredging numerous shoals in the river.

The project of 1870 was for a channel sixteen feet deep, with a minimum width of three hundred feet. Later on the project was changed, so that at the present time the improvements are being made for a channel twenty or twenty-one feet deep, depending on location and character of material of the river bed.

Having adopted the method of bank measurements in place, as being the most accurate one for determining the amount of material removed above specified grade planes, it was necessary to make detailed surveys of all the shoals. These were generally made in the summer time, but nearly every winter since 1870 soundings have been taken through the ice on the canal or river at such places where it was necessary to check the amount of the season's work as estimated from the scow loads, or where it was difficult to sound from boats or raft on account of the rapids or the frequent passing of steamboats.

At first the ordinary woodman's ax was used to chop the holes through the ice. After chopping through to water or as deep as convenient with the axes, then ice chisels were used to finish cutting the holes. The thickness of the ice was usually from twelve to thirty inches, but adjacent to docks and the canal piers it was often six feet thick. On account of the curved edge of the axes, they would not cut rapidly after the holes were fifteen inches deep.

A change was made to the ship carpenter's ax, which had a broad straight edge, with square corners. With helves three and one-half feet long, the weight of each ax was six and one-half pounds.

The best choppers could not stand to do more than ten to twelve days continuous work, as the muscles of the forearm would be badly strained from the constant shock, as it was necessary to grasp the handle firmly to prevent the ax from turning.

The average cost per sounding of the several ice surveys, where axes were used, ranged from five to fifteen cents, the mean being about eight cents per sounding.

Various devices were considered for making the holes easily and quickly, but none were successful, till in January, 1892, a local machinist succeeded in making an auger that would bore a three-inch hole through ice. Though the auger was poorly made and the machine crude, it was purchased by the United States and used on the Hay Lake ice survey during March, 1892.

Two men by working very hard could bore as many holes in a day as three axemen could chop. This was not very satisfactory, but it showed the possibilities of the machine, and I believed that it could be developed so as to completely solve the problem of making the holes rapidly. While in operation the defects of the machine had been fully noted and the necessary improvements were afterwards carefully determined.

Two new machines were built as shown in the sketches, and were used on the surveys of last winter for three months. The average day's work of two men with a machine was equivalent to what 12 to 15 axemen could do in one day's special work.

The auger is made by bending a bar of three-quarter inch square tool steel in a spiral around a bar of $1\frac{1}{2}$-inch round iron; the best distance for lead of spiral is two and one-half inches from center to center. The lower end is drawn into a chisel edge, which is widened to one and three-sixteenth (1 3-16) inches, so as to clear both the inside and outside of the spiral. Great care has to be taken in sharpening the auger, as one stroke of the file will change the edge so as to make it quick or slow cutting.

The auger is fastened to the shaft by means of a thread and jam nut on its shank. The shaft is made in sections of five feet of one and three-fourths ($1\frac{3}{4}$) inch round iron. A keyway slot three-eighths ($\frac{3}{8}$) inch wide and three-sixteenths (3-16) inch

deep is cut the length of the shaft. The revolving motion is transmitted to the auger by turning a crank fastened on the shaft of the driver of the bevel gearing; connections being made by means of a lug in the bore of the bevel pinion traveling in the groove of the shaft as it moves up or down.

An iron tripod seven feet high is placed on the frame. A line fastened to the swivel in top of shaft and passing through a block hung from top of the tripod is used to raise the auger the instant it cuts through the ice, and holds it up by passing a knot in the line into a U cleat.

By holding taut on the line the auger is kept from binding when changing from snow ice to clear blue ice.

In the first machine the bevel gearing was 48 to 24, the diameter of the driver being nine inches; in the second machine, 52 to 17; diameter thirteen and one-half inches.

They would cut through one to three feet of frozen snow and 24 to 30 inches of ice in eight seconds, 12 turns of the handle of No. 2 being necessary to that of 18 to 20 turns with No. 1, both being made in the same time; the greater speed of the latter being very fatiguing relatively to the extra power required for the former.

The two men operating a machine change places at the end of every line.

Time of beginning and finishing each line of holes was kept for each machine for two months. The average time per hole was for machine No. 1, $26\frac{2}{3}$ seconds; machine No. 2, $25\frac{3}{4}$ seconds. All delays from time of beginning to quitting work for each day are included in the above. The best record made was that of 51 holes, 10 feet apart, in 12 minutes, through 26 inches of ice, or an average of one hole every 14.1 seconds. The same morning's work with that machine, No. 2, was 561 holes in $3\frac{1}{2}$ hours. (The last day worked was April 5; 1479 holes were bored with the two machines in $3\frac{1}{2}$ hours.) It is much easier and quicker to sound through the bored holes than the chopped ones; also the sounding poles will last about five times as long in the former case. Frequently there was six to eighteen inches of water on the ice. At such times the work with the machines was not delayed, but would have been if axes had been used to chop the holes.

Teeth were broken in both the cast iron gears during the extreme cold weather of thirty degrees below zero.

For this winter's work we have three machines and the cut gears are of steel. No. 1 is 52 to 17, diameter of bevel driver $13\frac{1}{2}$ inches; No. 2 is 98 to 28, diameter of bevel driver, $12\frac{1}{4}$ inches; No. 3 is 112 to 28, diameter of bevel driver, $14\frac{1}{4}$ inches.

It is expected that the gear of $3\frac{1}{2}$ to 1 will give the greatest efficiency.

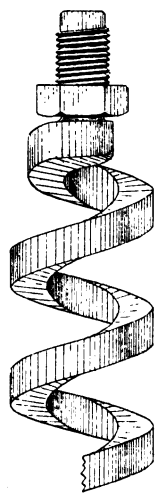
The party employed in making the ice surveys camp out in tents. The camp site is selected as near the work as possible, but on shore, where the tents will be well sheltered by the balsam trees. No fires are kept from 9 p. m. to 5 a. m. Fur overcoats are used in place of sleeping bags. The method used in making the surveys is as follows:

The equations of the two lines parallel to and 250 feet from the center line of the channel were computed, and the coördinates found of points every 500 feet on each line, and the azimuths determined from two or more shore stations to the several points. In the field work, opposite points on the two lines are alternately located by lining in sight poles from two shore stations, signals being given by the transit men with red and white flags six feet square. The transit intersections are marked with stakes placed in holes bored with ice augers. Intermediate stakes are set at the ends of the cross-sections by lining them in between the successive 500-foot stakes, the distance between the cross-sections varying from 10 feet for rockwork to 50 feet for sand or clay.

Cross lines of heaviest maitre cord, tagged every ten (10) feet, are stretched between corresponding stakes on the side lines; then holes are bored at each tag.

Soundings are taken with Norway pine or spruce poles, which are marked into feet and tenths of a foot. Quarter-hourly water gauge readings are taken on a stake driven in shoal water one to five feet deep. As the ice rises or falls with the changes of the water level, the zero of the gauge should be referred every morning, by means of level readings, to some permanent bench mark ashore. It is a good plan to cover the stake at night with brush and loose snow. With the conditions the same as last winter, viz., from one to five feet of ice, the aver-

age thickness being 26 inches, and the frozen snow one to three feet deep, the following organization of the party would be the most efficient: One chief of party, who records the soundings, two men for sounding, six men to operate the three boring machines, two men to move the tag lines and mark the places where the holes are to be bored, two or three men to shovel the snow after the holes are bored, so that the sounders can see the water surface, one water gauge observer and one cook.

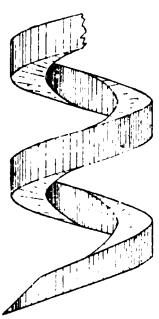


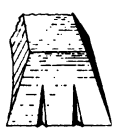
SKETCHES SHOWING

AUGER FOR ICE BORING MACHINE

AS USED IN TAKING SOUNDINGS

SCALE ½ : 1 AND 1 : 1





CUTTING EDGE

The cost of such a party would be about $1,000 per month. An average of 3,000 holes could easily be made per day of eight hours. For twenty to twenty-five days work per month the cost per soundings would be $1\frac{1}{3}$ to $1\frac{2}{3}$ cents. The soundings would be more accurately located and the cost less than surveys made from boats in the summer time.

Other uses of the ice boring machine suggest themselves, viz.: For fishermen in their villages on Saginaw and other bays, for cutting their spearing holes; also it would be very useful to those cities where there is danger of the spring floods carrying the ice jams against the bridges, as deep holes could be quickly bored in which to place the dynamite cartridges for breaking the jam.

THE SWIM FOR LIFE.

BY W. L. COFFINBERRY.

The camp-fire of a surveyor, like the forecastle of a ship, is the auditorium of many a wild tale, and many a rare jest. The nomadic and eventful life of a surveyor is not without its petty romances, its perils, its wonderful escapes, its stirring incidents by flood and field; and the natural and proper field for the recital of those anecdotes and wild "yarns" of which every experienced disciple of the compass and chain usually carries a full budget, is the cheerful camp-fire in the depths of the lonely forest, where a circle of eager and appreciative listeners are sure to be gathered after each day of toil, to while away the evening hours with song, jest or story. The place to hear these tales is undoubtedly there: but the one I am about to relate may possibly be deemed worthy of a larger audience, and a less ephemeral existence.

In 1853 I was engaged in fulfilling a government contract in the wilds of northern Michigan, with the usual party of assistants. Our work led us, in August of that year, to Muskrat lake, town twenty-two north of range eight west.

Our axeman, a fine, bold, powerful young fellow, "standing six feet in his boots," was the most intelligent, gentlemanly and sociable member of our little circle, and had won my entire esteem, confidence and friendship, by his industry, assiduity and many good qualities. He was the general favorite of the camp, and was always first in either business or pleasure. We had given him the *soubriquet* of "*Blaze*," from his particular branch of the business.

In order to "meander" the lake, a beautiful sheet of clear water some three or four miles wide, and of an irregular, oval form, we were obliged to construct a canoe, large enough to transport the party from point to point, together with their instruments. This task was completed on Saturday evening, and we hauled our new boat partly up on the beach, ready for use on Monday morning, not deeming it necessary to further secure it. Early Sunday morning, the cook, who was up preparing breakfast, called out suddenly that the boat had floated off the shore and was drifting out into the lake. Blaze, who was a fine swimmer, instantly got up, ran down to the water's edge and plunged in to swim out after our truant canoe. The rest of our party remained in bed, supposing he would find no difficulty in overtaking and bringing back the boat. Some time had elapsed when the cook came to the door of the tent and called me, saying that Blaze was getting into a bad scrape, that he was already some distance off the shore, and no nearer the boat than when he started. I immediately arose and ran down to the shore.

To my astonishment Blaze was a full half mile out in the lake, and the boat was drifting rapidly away from him before a light breeze. Before I could make up my mind whether to call him back, the wind lulled and he nearly reached the canoe. But when he seemed almost ready to grasp it, the breeze suddenly freshened again, and it receded from his touch with a celerity that soon left a wide gap between them. Then the wind lulled again and he gained upon the chase, only to be again disappointed of his prize. In this tantalizing manner he had already been drawn, I thought, too far from the shore to return with safety, and I checked my impulse to call him back, hoping that the next lull of wind would hold for a moment

longer, and end the wearying chase by placing the coveted prize at last fairly within his reach.

When I looked it seemed to me that he did not swim as strongly as at first; that he was growing weaker. Would the breeze never lull? I asked myself as I noted his progress, with white lips and a heart that seemed like lead in my bosom. No, the boat constantly receded and he was now fully a mile from shore.

Suddenly he turned and shouted to me, though so far out his voice floated distinctly over the water, "How far out am I? Shall I come back?"

How bitterly I reproached myself for not calling him back at the outset. But now regrets were vain. There was no way in which I could aid him, no other boat on the lake, and none of the party could swim half way to him.

Steadying my voice and bracing my nerves by a strong effort, I shouted to him as firmly as I could, "Not far. Go on! You'll soon catch it."

He turned and commenced the pursuit again. I knew he was nearly exhausted by the way in which he swam. My knees shook under me as he steadily receded, and I would have prayed—I did pray, if strong desire and fervent sympathy is heard at the throne of the Eternal Master of Life, but I knew that mortal words had no power to turn or set aside the purposes of the Almighty.

Slowly the swimmer struggled on, growing less and less visible as the distance increased, till his head alone could be seen, a dark, small speck on the distant waves. Minutes elapsed in profound silence, and an intense agony of watching on my part without lessening apparently the distance between the swimmer and the boat, which was now his only chance of escape from drowning.

Then the breeze grew less again, it puffed, failed altogether, and he gained upon the chase. Would the lull continue? He neared it, hardly a visible space separated them. There was a ripple on the water—no; it died away, and his hands are lifted to grasp the prize—he has it.

But could he, exhausted as he was, get into the canoe without upsetting it, or would he cling to the side until it had

drifted ashore? A minute, two minutes elapsed, and I had not seen him move. Suddenly he lifted himself clear from the water and landed in the canoe safely. Then I knew that he was saved, for the paddles were in the boat, and he could be as long in returning as he chose.

With a feeling of inexpressible thankfulness and relief, I turned and went back to the tent, my nerves all unstrung from over-excitement, and flung myself on my blanket, weak as a child; nor did I recover my firmness until the gallant Blaze had returned and joined me.

He was utterly exhausted and flung himself down on the ground, wet as he was, utterly unable to make any further effort. Of course he received every attention at our hands, but it was past noon before he could leave the tent or partake of food, and no doubt will long remember, as I shall, his swim for life in the clear waters of Muskrat lake.

MR. HODGMAN: This paper was written by W. L. Coffinberry, now dead. He was a member of the old Michigan Surveyors' Association, and one of the pioneer government surveyors of the State.

PROF. DAVIS: Who was the hero of that adventure?

MR. HODGMAN: He was one of the directors of the Michigan Engineering Society.

PROF. DAVIS: Yes, and his name was Dorr Skeels.

Mr. TEED: I think it must be the same boat I had some bad luck in. We attempted to cross Muskrat lake, but we didn't get across, we all got drowned in the middle of the lake.

TRYING TO SURVEY IN EAST TENNESSEE.

DORR SKEELS.

When we were about ten years old, a party of land surveyors passed along the north side of father's farm—a part of the "Hornby tract"—in the state of New York, on a resurvey. Boy-like, with eyes bulged out and mouth wide open, we watched every motion of each man, but were most interested in the "big man" with the compass. We can go today and "put our foot" right on the spot where he set his instrument. Our interest in him was so great that the next day we had a compass, formed from shingle and clap-board with the old jack knife, on the same point; and though the well-formed needle would not traverse, we succeeded in tracing all the lines around the dear old farm to our entire satisfaction.

A few years later we came in possession of "Fremont's Exploring Expeditions," which became a part and parcel of our daily life. It was our companion when going for a pail of water, when going to mill on horseback with the sack of corn, when going through the woods for the cows—in fact, in all our occupations except trout fishing, until most of it was committed to memory. As a result of this companionship, we decided, notwithstanding it might be a hard and rough life, that we would be a surveyor. Perhaps in the making of us a poor surveyor, some other profession lost a shining light; but a surveyor we are.

My friends, when reading the reports of explorers, engineering and surveying parties, and land lookers, how little we realize the danger, the narrow escapes from death, the exposures, the "from home and friends" feeling, until we make up our pack and go into the woods where in actual contact with these things we commence the duties of our loved profession.

In 1853 we put our "necessaries" into a new two bushel bag, and, in the employ of our lamented W. L. Coffinberry, made our first surveying trip. Many of you know much better from

actual experience the roughing, the trials, all, than my tied tongue can relate.

In the winter of 1887, as a surveyor, we went with a party to Claiborne county, Tennesee, to make a survey of some lands for the purpose of a rude topographical map, to locate coal veins and timber, and to determine exterior boundaries of exceptions. The parties had had deeded to them about 125,000 acres, commencing at a stone in "Cup's Gap" top of the Cumberland mountains, thence northeast to the top of Mingo mountain, thence northeasterly to a stone on state line near Bennett's Fork, thence west along the state line thirteen miles to a creek, thence along the creek three miles, thence southward to the crest of the Cumberland mountains, thence along the crest of Cumberland mountains to Cupp's Gap, the place of beginning, with a great number of exceptions.

In order to locate the timber, coal, and whatever else of importance there might be, we ran parallel lines one-half mile apart, using a Young's compass with tripod, from the crest of the Cumberland mountains north to the state line, and from the State line south to the top of the Cumberland mountains, setting stakes at every twenty chains, noticing streams, ravines, mountains, spurs, etc., our longest line being 396 chains or about five miles. All measurements were made on the surface of the ground, or, as stated in the deeds "surface measurement," one instance of which will sufficiently illustrate. Going over a ledge of rocks we came to a nearly perpendicular descent of about 120 feet. The chain was let down one length, and the head chainman noting where the lower end came on the side of the rock, called out, "Stuck; let her drop," calling it two chains, while the actual distance passed over was about one-half chain.

The member of the company having this work in charge often cautioned the chainmen to be careful in their chaining, and would say "for I want these stakes to be in line both ways." We told them perhaps some two might be in line, but we would not vouch for more.

Those of you who have prosecuted work in the mountains are aware of the difficulties in projecting a straight line in such a region. Now along the side of a steep slope, then over

a seemingly impassible ledge of rocks, on up the steep ascent, where we remove one leg of our tripod and use it as a setting pole, the reward being the pleasant sensation of overcoming obstacles.

We learned we were not the first in those solitudes, as we often found the still of some "moonshiner" tucked under a ledge on the mountain stream.

There have never been any sub-divisional surveys in that part of Tennesee. There the county surveyor is the one necessity. A party wishing to locate a tract of land, after looking the ground over, calls out the county surveyor and goes with him to the location selected, making a "beginning corner," a rock or tree being taken, as for instance this one taken from our notes: "Cupp's 35-acre tract, at black gum with three cross marks on side, on path leading to Watson's, 62 chains south of Monson's corner, top of Mingo mountain, second beginning corner of Cupp's 35-acre tract." The place of beginning is designated as the first beginning corner, and each angle as the second beginning corner, the third beginning corner, etc., the last which is also the first, being the closing corner. The party wishing to purchase the lands points out to the surveyor what he wishes to have enclosed in the tracts. They pass over it, marking corners, not marking any lines. The surveyor makes an estimate of the area, surface measure, and certifies to the same. The buyer takes this to the land office, pays one cent per acre, and receives a patent for the same. Soon after a second party wishing to locate a tract goes through the same rigamarole, and if the boundary lines of his tract pass over on to those of the first party, he gets his patent just the same; so that many claims lap and interlap on to the claim of others, thus, making, as shown by the map, a difficult problem, and one that cannot be solved by surveying. Here, surely, "course and distance must give way to monuments."

The timber here is poplar—our whitewood—chestnut, many varieties of the oak, black walnut and hickory, the oak and hickory growing on and near the top of the mountains, the other kinds on the slopes. The coal lays in veins of from two to eight feet in thickness, one we found being fourteen feet in thickness, and go through the ridge parallel with each other.

In tracing the state line we found monuments of cut stone about 6′′ by 10′′ face, some two feet out of the ground, with the letter "T" on the Tennessee side of the line and the letter "K" on the Kentucky side, also figures on the east and west sides of the stones (the line running east and west) showing the distance in miles from the place of starting. Coming to these monuments we could but think of our "floating state boundary."

NEW YORK STATE BOUNDARIES.

J. B. DAVIS, ANN ARBOR.

By chapter 421 of the laws of 1887, it became the duty of the State engineer to examine all the monuments on the boundaries of New York. See State Engineer's Report for 1887.

Two thousand three hundred twenty-four dollars and one cent were expended in examinations and surveys.

By chapter 449 of the laws of 1886 a circular was sent to the supervisor of each of the border towns containing a synopsis of the law, and the number and descriptions of the monuments on the State line in his town. Each supervisor reported the condition of these monuments in his town.

Canadian boundary, dated 1842. There are two border counties containing nine towns and 135 monuments. Forty-five years after, 24 of these were found broken, tipping over, heaved out, or missing. They were cast iron obelisks six feet long, six inches broad at base and four inches at top, except a few of stone.

Vermont line, dated 1814. There are two border counties and seven towns with twenty-six monuments of marble, stone, trees or stakes. In one county (Washington) with 21 monuments some were broken off, lying on the ground, or gone. In the other county (Renssalaer) none of the five monuments could be found at first, but later three were reported as injured so as to need replacing. In 73 years nine out of twenty-six

monuments were reported in a more or less damaged condition, broken, removed, or in need of replacement.

Massachusetts line, dated 1787. There are two border counties. There were 50 monuments, and 17 transit posts, to mark this line. These monuments were stakes standing in heaps of stones, or trees, and were located on the highest ridges of the mountains along this line. Could not be identified without a resurvey which was made by O. S. Wilson in 1887, one hundred years after the former survey.

Connecticut line, dated 1861. There are 51 monuments of sawed marble or cut granite, eight inches square at the top, and rough granite slabs of varying breadth and thickness. These stand about two and one-half feet out of ground and two and one-half to three and one-half feet below ground. This line was reviewed by commissioners in 1878 and approved by the legislature of 1880. These monuments were reported in good condition 25 years after being set.

New Jersey line, dated 1884. This line was marked by a station rock in Hudson river at one end and the tristate rock on the Delaware river. There were three classes of monuments set, in all 121. These were mile, railroad, and highway monuments. They were set at every mile, railroad, stream or highway. They were granite four to four and one-half feet long, tops dressed to six inches square and with grooves in the top marking by their intersection the point of the survey. There were witness trees made. This line bounds two counties in New York, Rockland and Orange. In Rockland were 83 of these monuments, all found in good condition. In Orange there were 48 monuments, some broken, some out of ground, one with a large wall built over it, and the tristate rock monument broken off and lying in a cemetery near by, three years after, or in 1887.

Pennsylvania line, dated 1886. Line extends along eight counties. There were set monuments at highways, railways, rivers, town lines, astronomical stations, and as mile posts. In the county of Tioga there were 23 mile stones, and others as required. Reported next year after date of survey as some heaved by frost, one out of ground, two broken, one buried under a railroad embankment. In Steuben county were 40

mile stones with others as needed. Two of these were heaved by frost, one of which laid on the ground. Twenty-two monuments were imperfect, heaved by frost, washed out, or buried, the next year after the date of the survey.

The Massachusetts line was examined by Mr. O. S. Wilson in 1887. He ran a precise transit line from the monument at the south end of this boundary passing through a well defined mark on a rock ledge two and one-half miles north and continued this line the whole distance, 50½ miles, searching for the evidence of the survey of one hundred years before. The more permanent and easily indentified marks were all found as the region is mountainous and poor for farming, especially where these marks were placed. Other monuments and evidences were examined that were of more recent date. They were found to stand mostly east of this line from 15 to 70 feet, the last one being 108.5 feet. The marks in rock ledges were the best. Stone piles were found where left except in localities subject to invasion by man. After this survey the state engineer, Mr. E. Sweet, corresponded with the Massachusetts authorities and endeavored to obtain coöperation on their part, as they were then engaged in making a complete survey of the state. This effort seems to have been fruitless and Mr. Sweet being succeeded by Mr. John Bogart in 1888, the matter ends with Mr. Sweet's report for 1887, no advantage being taken at that time of Mr. Wilson's excellent work. With Mr. Bogart came in a new set of men, apparently, and there seems to be no reference to the matter in Mr. Bogart's reports till that for 1890, when the triennial examination of all the monuments on the state lines was made as required by the law of 1887, above referred to. None of the state engineer's reports that I have are indexed, and they have not been as carefully proof read as might have been. These facts need to be borne in mind by those consulting them.

Pennsylvania line. Examination of 1890, made by coöperation between the states under a formal recorded agreement between the state engineer of New York and the secretary of internal affairs of Pennsylvania.

Two men, engineers, one from each state, made the examinations and repairs. The reports of these men show they did not

run lines and make measurements as some monuments were not seen for briers, brush, etc. One quotation will suffice.

"Milestone 56 is situated in the middle of a highway, and as it had been covered up in working the road it was not deemed necessary to dig it out."

The time was too short that was allowed for doing this work thoroughly. Many repairs and restorations were made, however, even if it was but four years since the survey of the lines. The report complains of excessive heaving of stones by frost as does that of 1887, the next year after the survey, and hints at imperfect setting. Besides this the most dangerous thing to the welfare of the monuments is man.

The New Jersey line was examined by coöperation of the states and was done by an engineer from each state. The examination was thorough, the reports full, the repairs apparently adequate and the line was left in good condition, the only one around the state. The work of these men gave some good suggestions. In the joint report are these words:

"In conclusion we have to state that the results obtained by this examination clearly demonstrate the necessity of coöperation on the part of the two states in all further examinations. The value of the law enacted by the state of New York is clearly proved, and the interval of time named between successive examinations (namely three years) is none too short, and as it is surely the part of wisdom to maintain a line established at so great a cost of time and money, and as this can only be done by coöperation and the passage of like laws by the two States we recommend most earnestly that such legislative action be taken." The time referred to was over 100 years as noted in the report itself, and the cost—no one knows its magnitude. Beneath the stone used as the ordinary monument mark along this line is buried an earthenware disc six inches in diameter one inch thick, with a central hole. The disc is buried six inches below the bottom of the stone and the hole in it marks the place. These discs are set in wood ashes, generally, and notes made for finding the monument and disc by noting the soil and reference to near by objects. These notes are good enough to be of use three years after being made.

A monument in the Delaware river on this line known as the tristate monument marks the place where the eastern line of

Pennsylvania (the Delaware river) intersects the northern line of New Jersey. Concerning this the report says: "The point which this monument intended to define was originally indicated by a crow foot cut into the natural limestone rock and which in 1874 was very plain, although its cut edges were somewhat smoothed by the exposure of 100 years. In 1874 the United States Coast and Geodetic survey, at the request of the Geological survey of New Jersey determined accurately the latitude and longitude of this point, and at the close of the work marked it by drilling a deep hole in the rock and fastening in it a copper tube filled with lead and setting and describing proper witnesses of its location. The station point according to this determination is in latitude 41° 21′ 22.63′′ north; longitude 74° 41′ 40.70′′ west from Greenwich."

"By order of the joint commission on boundary line between the states of New York and New Jersey the copper bolt was excavated October 30, 1882, in making foundation for the existing granite monument, the center of which was placed directly over the point occupied by the bolt. * * *

In the spring of 1883 the upper portion was broken off by ice, and on May 21, 1885, by order of Commissioner Leavenworth of New York, and Commissioner Cook of New Jersey, the remaining portion was redressed to the existing dimensions which are as follows: Two feet four inches long, one foot four inches wide, and one foot five inches high above the surface of the rock in which it is imbedded. Upon its top surface it was marked with one quarter inch groove showing the direction of the lines of the three states which meet there, and within the surface bounded by the lines the initials of the respective States are cut. The north side of the stone is further marked with the words "Tristate Monument."

This monument is built into the natural rock at the junction of and near the high water mark of the rivers Delaware and Neversink, and at this date (1890) is in good condition as above described."

Connecticut line. The report says: "This line, as all the others was established only after long controversy and endless correspondence and litigation. The desire that the line between the two states be determined, was first made known in

1850. Many commissioners were empowered by the two states to settle the vexed question as to where one state commenced and the other ended. The culmination of the dispute was reached in 1860, after repeated failures by commissioners of the two states to agree, when the New York state legislature empowered a commission 'to survey and mark with suitable monuments the said line.' This was done and though the state of Connecticut ratified in 1878 the line so monumented, the total expense was borne by New York alone." This line was found in a condition called "general good" after thirty years (1890) no care of it being taken in the interval. No survey was made. Monuments cut stone for the greater part. Partial coöperation only on the part of Connecticut. No repairs were made, only an examination. There are 100 monuments, thirteen need repairs, one missing, one moved twenty feet from line, one has no inscription, one broken off, nine heaving—twenty-six are out of order—or one in four. The examination shows these things and that New York is powerless to effectually remedy them, alone. Several places show the distance between monuments to be excessive, the examiner considering one mile to be the limit of useful spacing. These monuments are of sawed marble, cut granite, uncut granite and iron bolts.

Massachusetts line. Twenty-one monuments examined in 1890. Three of these relate to the cession of 1853 to New York, known as the Boston Corner, eighteen are on the line and relate to the survey of 1787. Ten are correct, two are possibly correct, six are lost. No coöperation from Massachusetts. No repairs in consequence. Apparently Massachusetts has done nothing about the matter since 1887 as noted in the correspondence hereinbefore referred to. The examiner recommends that witness monuments be planted to preserve the location of the ten points known to be correct.

Vermont line in 1890. The report says: "The lapse of seventy-seven years from the time of the original location of the line to the present examination has resulted in the loss of most of the perishable monuments, and this examination was confined to those monuments which were originally of substantial material. There were thirty-three of these points, and only

eight of them were found to be in good condition, three of them are missing and all the others are in various conditions of dilapidation, as shown in the subjoined report." * * *

"It appears * * that eight of the twenty-three controlling points of the line were never placed; that eleven of them were inadequate for the purpose and only three of them remain; and of the remaining four, one only is of cut stone, two of rough uncut stone, and one is not positively identified as being the recorded point; and it also is conclusively shown that generally when repairs to any monument are necessary, insufficient data is furnished for rerunning the line for its bearing in any one specific direction, and that a long and expensive survey would have to be made from such points as are determined definitely. Under the existing law this would have to be done, not only once, but probably at each examination (when cooperation is secured) which would prove very expensive."

"This work should be done by the two states, not blindly and with the idea that simple repairs were made to the line but once for all, and properly done, with the full understanding that the line between them is nearly lost, in its present condition it really is an imaginary one, and that the interests of each state demand its permanent establishment." With these points once properly marked the expense of maintaining the line would be but slight and I therefore recommend that such legislative action be made as will empower the state engineer and surveyor acting in conjunction with the authorized agents of the state of Vermont, to re-locate this boundary line and mark permanently all points of angular deflection, all mile points and crossings of highways and railroads, and the terminal points of the line.

The same person examined the lines next to New Jersey, Connecticut, Massachusetts and Vermont. He adds a general report noting the diversity of methods, marks and monuments on the different lines. From this report I cull the following memoranda.

"The interest in a line is held equally by the adjoining owners." Repairs should be equally shared.

They must coöperate in all effectual remedies for the loss of the line.

Uniform methods of making repairs should be employed everywhere in the state.

Improve the records of monuments, marking and recording substantial witnesses. As a result of his examinations he says:

"The New Jersey line is in perfect condition."

Ten per cent of the monuments on the Connecticut line need repairs and they are too few.

The Massachusetts line "is simply a reminiscence."

The Vermont line is nearly like the Massachusetts line.

Canadian line in 1890. The report says:

Total number of monuments	130
Omitted from examination	5
Disappeared entirely	7
Heaved entirely out of ground	4
Broken off in the ground	4
Badly cracked	5
Mutilated so as to require renewal	9
Tilted so as to require readjustment	6
Heaved so as to require readjustment	14

And the following list shows the number of points not heretofore marked, which should now be determined and monumented:

Ten highway or road intersections.

Two railway intersections.

One county corner in New York.

One county corner in Quebec.

Seven town corners in New York.

Four town corners in Quebec.

There are, therefore, required at least fifty new monuments, twenty-five to mark additional points and twenty-five to replace old ones. Five monuments were not seen and consequently, may or may not, require attention.

"The importance of early action in this matter can hardly be over-estimated. This line has now stood for forty-five years without attention, and each year's neglect will augment the difficulty of replacement on a rapidly increasing proportion. The old monuments were not of the best design for permanence in this high latitude being set but three feet below the surface, and of cast iron so thin as to yield readily to the blow of an

ax. The region is often very uniform in its topographical features and in the majority of cases no monuments can be identified without visiting adjacent ones since they are all alike and bear no designatory number."

"But one of three certain monuments was seen. The report says: "As there was no time to measure through, it is impossible to state which was the one discovered."

"One of the official posts, which was not used in the original settling, has been appropriated by one of the store keepers of the village of Fort Covington, N. Y., and is now doing service as a hitching post."

Partial coöperation on the part of Canada. No repairs. It is a national boundary.

The above given memoranda are extremely disconnected and are intended only to give a glimpse of what is set forth in the reports of the state engineer and surveyor of New York for the years 1887 and 1890. A careful reading of these reports will bring to light much more in the same lines. The reports of 1890 also contain something on the restoration of the old county boundaries which has also been taken up.

Certain things seem plain. The people of New York have little to show for all the money spent on their boundaries. The present law provides for hasty examinations based upon imperfect data, without survey or measurements owing to the time limit, and certain more or less perfect repairs, every three years. The monuments in use are generally unfit and inadequate. Notice the very large number rendered useless by frost heaving them. A transit cannot usually be set over them. But any person can easily note items of this kind.

Boundaries of states or nations should be natural features, water preferably. Where the actual boundary line cannot be precisely indicated on the ground or the water because of the peculiarities of the natural feature that is to form the boundary let the states or nations extend over a belt or strip including said boundary a joint coöperative jurisdiction, each conforming to the laws of the other as far as may be necessary, within this strip or belt. Where the boundary must be lines of survey they must be objects of common care, and protection by coöperative measures.

It seems that mankind are the worst enemies of the monuments marking the surveyed lines. The monuments must be such that man cannot well destroy them. No one form or style can be used everywhere but the following is suggested: A suitable casting buried six to eight feet in the ground which carries the mark designating the point of survey. Above this a particularly strong conical cast iron case covered by a hemispherical cap or cover, not easily removed, the case to extend from the casting below, though not resting upon it, till two feet above ground. For access to the point, remove the cap, lower a light into the cast iron case, and suspend a plumb line from the mark below. This for use in soil. Only general terms are used purposely. The part of the monument above ground should have nothing whatever to do with the position of the line. Stone monuments need not be experimented with any further. Within the cast iron cap, to the case place a lead or copper tablet bearing an inscription telling what one ever needs to know about the point it covers. Make some law about the preservation of these things and make it as near self operative as possible by rewards, division of fines, etc. Interest the near by residents in the preservation of these monuments by instructing them with information regarding them and showing them they can connect the surveys of their own property to them. Triennial examinations are evidently needed or some equivalent thereof.

Considerable is said in these New York reports about setting monuments at road intersections. The state should not be charged with this duty as it involves finding and restoring the center line of the highway near the state line.

Local surveyors sometimes claim to know the location of these state boundaries without possessing a bit of trustworthy evidence of their original authoritative location. How this happens may be discovered from an examination of the New York report upon its Massachusetts line for 1890. In the original survey of that line in 1787, eighteen transit points are recorded by the commission marking the survey, also at the termination of each mile a stone heap was placed. The careful survey of 1887 failed to locate any of these mile monuments. "Monuments supposably marking the state line, have been placed by

different parties on the roads leading from one state into the other; but as the records of 1787 identified none of these points, and as there are no records which show that these points are authoritative or indeed that they mark the true line, no examination of them was made." Had the author of the above sentence but consulted the record of Wilson's survey of 1887 he would have found ample evidence that such marks are not on the state line. The local surveyors were undoubtedly using them as state line monuments. Any of them might have readily testified in court that these monuments and marks were on the state line. A lesson for all of us.

It took at least 200 years of contention to fix upon the Connecticut line, and various other long periods of time to settle the other boundaries of New York state. Few of us have realized that the Connecticut line became fixed in 1860, the New Jersey line in 1774 but was permanently marked only in 1882, and the Pennsylvania line became well marked in 1886. The Vermont line was a fraud in the first place and never has been fixed. The Massachusetts line has been carefully lost in the 100 years since it was surveyed by two sets of jangling commissioners, the first set not being able to go on because of contention. It would seem as if this state had made experiments enough for the whole nation but it is very doubtful if this kind of history stops yet.

Papers and reports relating to state boundary surveys contained in the transactions of the Michigan Engineering Society.

Michigan and Ohio state line, 1881 p. 14.

Monuments on the Pennsylvania and New York state lines, 1881, p. 16.

State boundary, Michigan, Ohio and Indiana. Geo. E. Steele. 1893, p. 77.

Report of committee on state boundary. 1888, p. 20.

MR. SEARS: The question is, how to make an indestructible monument.

MR. HODGMAN: Perhaps I don't grasp the matter fully, but there is just this point of interest to me in regard to the Wilson line. It is stated that Mr. Wilson took two known points on the boundary and projected from them a careful transit line for some fifty miles and at various points found what were said to

be monuments for the state line, at various distances away from the line that he ran. This does not prove to my mind that those monuments were not on the state line. The original survey and the monuments then located it seems to me determine the location of the line, at least after it has been accepted and acquiesced in for many years, whether they were mathematically located where they ought to have been or not.

PROF. DAVIS: Mr. Wilson first found two points and produced a line for the purpose of ascertaining where the others stood with reference to it. He understands that these monuments originally used, mark the line—but when I referred to the several monuments used by various persons, that were no where near the line of which he gave the record—his survey would show that these monuments were not on the line as originally marked down; yet surveyors are liable to use those monuments, calling them the line, supposing they were the line and testifying that they were, while not one was on the plat of the line. No official record or notice of them.

In regard to the question asked by Mr. Sears: I think that iron is the best material, any of us could make a plan for the casting below ground, and the thing that covers the actual mark should have nothing to do with preserving the point. It simply makes it easier to find it.

I have said in my paper that the marks should be six feet below the ground and the monument project four feet above, making a total of ten feet, and the state or the county, or the township even could afford to pay for a first class thing of that kind. Think what the people of the state of New York must have paid for the matter of some 500 or 600 monuments.

MR. HODGMAN: It seems to me that if cast iron is used it must be used in sufficiently large pieces so that a man cannot carry it off for a hitching post. It must be sufficiently solid too, so that he cannot knock it to pieces. It strikes me that it is sensible to put something in that no one would ever be tempted to take away for any other purpose.

STATE LINE BETWEEN OHIO AND MICHIGAN.

JAMES BLAIR.

Mr. President and Gentlemen of the Michigan Engineering Society:

I believe, if I recollect rightly, that our society has had a committee on the state line boundary ever since its organization, and I have hoped that the legislatures of Ohio and Michigan might be induced to establish by an accurate survey the line between these two states, in accordance with the act of congress of June the 15th, 1836. The intention of that act was that the line should be straight. The line as it was surveyed in 1837, by Andrew Porter with his open-sighted compass and wire chain, is about as near straight as the average rail fence built in a hilly country; and I for one hope they will never try to retrace the old line, but will give us one that is accurate. So far as actual monuments are concerned, they are very scarce. I see by reading the report of our committee as printed in the Michigan Annual for 1893, and also from a paper read before the Ohio Engineering Society last winter by Mr. Graham, it appears that Mr. Harris had doubts as to the accuracy of his own survey. Perhaps it might be well to recite the act of congress establishing the northern boundary line of the state of Ohio. Also a few examples of the field notes, selected and abridged from the original surveys, the survey of the state line by Andrew Porter in 1837, and later surveys by different county surveyors. I will place these field notes in three parallel columns, with the points which should agree with each other exactly opposite. So you may see at a glance how near the different surveys agree and how much reliance is to be placed on the records for finding the location of the state line from its intersection with the section and township lines, which it crosses. I will also give a little of my own experience. The act of congress referred to reads as follows. In congress June 15. 1836: "Be it enacted by the senate and house of representatives of the United States of America in congress assem-

bled; that the northern boundary line of the state of Ohio shall be established at, and shall be a direct line drawn from the southern extremity of Lake Michigan to the most northerly cape of the Maumee (Miami) bay, after that line so drawn shall intersect the eastern boundary line of the state of Indiana, and from the said north cape of the said bay, northeast to the boundary line between the United States and the province of Upper Canada in Lake Erie; and thence with the said last mentioned line to its intersection with the western line of the state of Pennsylvania."

It seems a contract was entered into between Robert T. Lytle, surveyor general of the United States for the states of Ohio, Indiana and Michigan and the territory of Wisconsin of the first part and Andrew Porter deputy surveyor, of the second part on the 4th day of May, 1837, for the survey of the aforesaid state line, and the said Andrew Porter certifies to having completed said survey through the following townships on the dates set opposite as follows:

Town 9 south, range 5 east, June 10, 1837.
Town 9 south, range 4 east, June 14, 1837.
Town 9 south, range 3 east, June 16, 1837.
Town 9 south, range 2 east, June 17, 1837.
Town 9 south, range 1 east, June 19, 1837.

From June 10 to June 19 gives eight working days, during which they surveyed at least twenty-four miles of the state line, but that was not all. Every time they crossed a section or township line running north and south, they were supposed to go to the nearest section corner south from the state line and re-survey said section or township line for a distance of a mile, showing in their field notes streams of water, line trees, swamps and other objects and the point of intersection with the state line and the $\frac{1}{4}$ section corner. This would make twenty-four miles more of surveying and twenty-four miles returning over their lines or seventy-two miles in eight days, or an average of nine miles per day. In the original surveys, such rapid work was sometimes done, but Mr. Porter discounts this heavily. On the 17th day of June, 1837, he surveyed the state line across town nine south, range two east, or six miles besides traveling twelve miles further on the north

and south section lines or eighteen miles in all. Were these north and south lines resurveyed? I claim they were not, at least in a great many instances, but were copied from the original notes, varying the distances slightly and writing up some new line trees, so as to look reasonable. My reasons for so thinking are as follows: If you should re-measure those lines and find that there was a miscount of say two or three chains in the original survey, you will find the same miscount in the state line survey by Mr. Porter. In the spring of 1891, I was called on to retrace the state line through section four, town nine south, range five east. Charles Ford an old settler having died and deeded what land he owned in Michigan to George F. Ford and what he owned in Ohio to L. L. Ford; both sons of the old gentleman. I found the southeast corner of the section and the east ¼ post and measured the distance carefully with a steel tape and found it fell short 1.06½ chains from the notes according to Mr. Porter. I proposed to divide this shortage proportionally and did so, but that was the commencement of the most infernal jangle I ever listened to, L. L. Ford insisting he should have the full distance called for on the Ohio side of the line, and the other brother, George F. Ford, being satisfied with my work. I also found the west ¼ post to the section and going south I found a compromise corner which had been set about thirty-three years before, the parties not being able to find the original corner. I measured north from said compromise corner and keeping track of Ten Mile creek as I crossed it, kept on to the ¼ section corner, 38.59 chs. From the location of the creek I made up my mind that the original section corner was formerly situated about 1.41 chs., south from the compromise corner. I therefore measured south 8.00 chs., from the west ¼ post for the state line and drove down a steel bar for a corner, I then caused corners to be placed at suitable intervals across the section and in a straight line between the two monuments which I had placed on the section lines, but they disappeared soon after and a wire fence was built about six rods north from my line. This last was a little more than George F. Ford was willing to stand, so he sold a part of the land to his brother Eugene F. Ford, and after a long time the three brothers signed a paper agreeing to leave the whole matter to the county surveyor of Lucas county and myself. We met March 30, 1893,

and measured from the southeast corner of section four to the east ¼ post, with the same result as shown by my first survey; but now found for the first time that said ¼ post was disputed by L. L. Ford and others residing south of the ¼ line. It being nearly night we concluded to adjourn until the next morning and during the evening I proposed we should go to the east line of section three, find the southeast corner of the section and then measuring north to the ¼ section corner, divide the distance pro rata and find how far south from said ¼ section corner the state line would be. Then I proposed going to the southwest corner of section five and measure north on the section line to the west ¼ section corner of said section five, and comparing our measurement with the original notes of the state line survey ascertain the point south from said ¼ section corner where said state line would intersect said section line and then place our monuments on the east and west sides of section four in a straight line between the points on the east side of section three and the west side of section five. The next day we carried out the aforesaid program with the following results: At the east line of section three from the east ¼ section corner, ran south $3.96\frac{6}{10}$ chs. to the state line. On the line between sections three and four from the ¼ section corner ran south 3.97 chs., to the state line. From the ¼ section corner between sections four and five ran south $6.05\frac{3}{4}$ chs. to the state line. From the ¼ section corner between sections five and six, ran south $9.59\frac{1}{2}$ chs. to the state line. I might here state that when we measured south from the west ¼ post of section four and set our stake for the state line it lined with the center of a fence running east, and it was claimed that this fence was on the state line as surveyed by Mr. White in the year 1858, which would indicate that he had surveyed from the same points that we had. Were any of us right so far? As Mr. Joseph Hofman the county surveyor of Lucas county, Ohio, was obliged to go home, we set no stakes in the interior of section four and we returned home the same night. Mr. L. L. Ford was getting more land than he ever expected but was willing to take all he could get, and the others were getting less. I told the parties interested that they should agree on a line between themselves. Matters remained in this shape for about three months, when they wanted me to make another survey. I told them I had

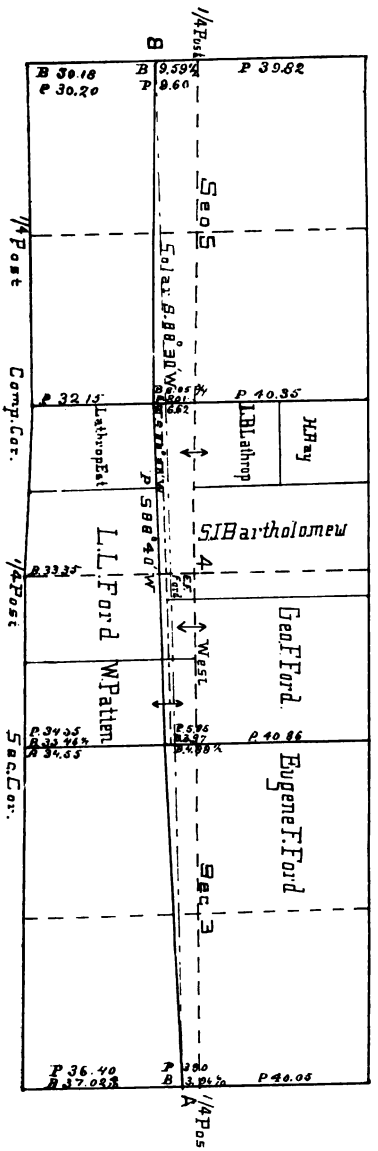
made two surveys and did not intend to have anything more to do with it, but recommended them to procure the services of Prof. Davis. I thought that would end the business so far as I was concerned, but was doomed to disappointment.

The parties interested finally agreed that L. L. Ford's north line should be so located as to give him all the field notes called for on the Ohio side of the state line and they would take what was left, and they again wanted me to survey the line for them. I finally concluded to try once more to satisfy them, so the 12th and thirteenth of last September again found me on the disputed ground. I set flags at the east and south ¼ posts of section 4, and setting my transit over the southeast corner of the section I took the angle between the two flags. I then set a flag at the southeast corner of section 4 and chaining to the south ¼ post, I set my transit over it and sighting to the southeast corner of the section, I turned off a calculated angle to strike the center of the section and set a flag. I ran north on this line 33.35 chs. and set an iron monument for the southwest corner of land now owned by Eugene F. Ford. I then set my transit over this last monument and sighting to the south ¼ post, I turned off an angle calculated to strike a point on the east line of the section 34.55 chs. north from the southeast corner of the section. I ran this line, first, easterly to the division line between the east and west halves of the southeast ¼ of said section, and then turning the telescope over I ran the line westerly to the west line of the section. The parties interested agree to abide by the above line regardless of what the two states may do in the future. I might here remark that the state line across section 4 runs through heavy timber for more than half a mile and we might naturally expect to find some of the line trees called for in Mr. Porter's field notes, but although we searched carefully for a long distance each side of our line, no such trees exist, and my experience on other sections has been the same so far as line trees are concerned. I will now submit a few samples of notes so you can judge how far you can rely on Mr. Porter's field notes. I will leave out line trees and some other items, but give the distances to streams of water, state line, ¼ section corner and the north section corner. I will place them in three columns, the first will show the original survey, the second column the state line survey and the third column will

show more recent measurements over the same lines by different county surveyors. It seems a little strange to me at least that Mr. Porter should fail to note any of the corners established by Mr. Harris in 1817.

A few samples of surveys:

Original Survey.	Porter's State Line Survey.	Later Surveys.
T. 9 S. R. 5 E.	T. 9 S., R. 5 E.	T. 9 S. R. 5 E.
North between secs. 2 and 3.	N. 30' E. between secs. 2 and 3.	North between secs. 2 and 3.
8.00 creek 80 lk. wide, cos. S. E.	6.50 to 10 mile creek.	8.86 to creek, cos. E.
	10.00 pass it.	
29.00 run 12 lk. wide, cos. S. E.	21.50 pass small creek 10 lks. wide, cos. E.	
40.00 set ¼ sec. post.	36.40 *State Line.*	37.02 4-10 to *State Line.*
59.00 run 2 lk. wide, cos. S.E.	40.30 qt. sec. post, reset it.	40.99 to ¼ sec. cor.
80.10 intersect N. bdy, 130 lks. E. of post.	47.75 pass small creek.	
	80.35 sec. cor.	80.74 to sec. cor.
North between secs. 3 and 4.	N. 15' E. between secs. 3 and 4.	N. between secs. 3 and 4.
	34.55 *State Line.*	33.64 to *State Line.*
40.00 set ¼ sec. post.	40.50 qr. sec. post.	39.43¼ to ¼ sec. cor.
80.60 intersect N. bdy. &c.	81.36 sec. cor.	80.61 to sec. cor.
North between secs. 4 and 5.	N. 30' E. between secs. 4 and 5.	North between secs. 4 and 5.
16.50 creek 50 lks. wide, cos. S. E.	20.15 to 10 mile creek along a road.	1.41 pass compromise cor.
	32.15 State Line along road.	16.51 to 10 mile creek.
40.00 set ¼ sec. post.	40.15 pass ¼ sec. post along road.	32.00 to State Line.
80.60 intersect N. bdy. &c.	80.50 sec. cor. along road.	40.00 to ¼ sec. post.
T. 9 S., R. 4 E.	T. 9 S., R. 4 E.	T. 9 S., R. 4 E.
North between secs. 2 and 3.	N. 15' E. between secs. 2 and 3.	North between secs. 2 and 3,
	23.20 to *State Line.*	
40.00 set ¼ sec. post.	39.90 pass ¼ sec. post.	38.91 to ¼ sec. post.
80.02 intersect N. bdy. &c.	79.96 sec. cor.	77.95 to sec. cor.
North between secs. 3 and 4.	N. 15' E. between secs. 3 and 4.	
	20.40 to *State Line.*	20.57 to State Line, this corner has been preserved.
40.00 set ¼ sec. post.	40.00 ¼ sec. post.	37.89 compromise ¼ post.
Being very swampy proceeded no further.	79.91 sec. cor.	76.75½ to sec. cor.
North between secs. 4 and 5.	North on road between secs. 4 and 5.	North between secs. 4 and 5.
	19.09 to State Line.	18.13¾ to State Line.
40.00 set ¼ sec. post.	39.91 to ¼ sec. post pass 12 lks. E.	37.97 to ¼ sec. post.
80.06 intersect &c.	79.90 sec. cor. 21 lks. E. of post.	77.73 to sec. cor.
	South connect between secs. 4 and 5.	
	39.99 pass ¼ sec. post, reset it	
	60.81 to State Line.	A large marked sycamore stump.
	79.90 sec. cor.	S. .71¼° W. 9 lks.



Distances marked P are from Mr. Porter's Survey. Those marked B are my own. The broken line is a straight line from A to B. The full line shows the state line according to Mr. Porter's survey in 1837, but all the bearings shown are my own. The intermediate line and figures to correspond show the compromise line according to the last survey.

MR. STRONG: I would like to ask, if during the examination of these lines, any steps were taken, and if so, what, to ascer-

tain the rights of the parties, each side of the line of occupation, as to the duration of time they had occupied.

MR. BLAIR: As far as Lenawee county is concerned, there are only a few pieces of land where the state line forms the boundary; sometimes they think they pay more taxes than they ought. If they would take the government plat, as a general rule they could come close enough to it for taxation purposes, but in some instances both states are taxing for it. In one case, a man owns forty acres in Ohio, and between the two states they have him taxed for five or six acres more than he has altogether.

In this particular section—this one place to which I call your attention, that line was run by a man from Toledo, in 1858, or about that time. That is in a sort of estate between some relatives—and the old gentleman is dead now, and I don't think there will be any difficulty in fixing that line. If they should attempt to hold it, they would probably do it by that old fence.

But this other, is in the case of a man dying some three or four years ago, and what he had owned in the state of Michigan, went to his children living on the Michigan side of the line, and the son in Ohio was to have the balance. That is in an unsettled state, but they grubbed this land, and pulled up the stakes we set. Well the other brothers did not want to let him have all that Ohio calls for. The state line as originally surveyed is certainly a very crooked line. It don't comply with the act of congress by any means, and I don't think that line was run across the sections in many places, as it was said to be, for if so there should be trees there. They are not only entirely wanting, but in many instances, a different kind of timber. We examined it very closely recently, to find some of the trees called for, and nothing of that kind was there.

In the section west of the township of Ogden, there was plenty of timber there, some that was standing when the state line was surveyed, and no timber of the kind described in the notes could be found. There is one corner there that they claim to be an original state line corner, that it has been preserved. and no one knows to the contrary. There are some probabilities that that was the line. There were two stumps ten or twelve years ago, that had marks, and the distance corresponded very closely with the stone monument.

MR. STRONG: Did you take any evidence as to those reported corners of the old state line?

A. There are no records on that, one way or the other, only this fence on the west side of section four; they claim that this was put up by Mr. Wood in 1858. They had no idea how he came to establish it there.

MANUFACTURE, USE AND TESTS OF WOODEN PIPE.

GEO. L. WELLS, ST. LOUIS, MICH.

Wooden pipe was one of the earliest means employed for conducting water for public and private uses. The logs were bored by hand from each end, sometimes the center was missed. Different crude joints were made for connecting them. They were placed in the ground with little or no banding, and it appears that there was no especial effort to remove the bark.

The sketches sent me by Major Tomassek of New York, will show the joints made there about 100 years ago, and the stop valve used. A similar joint was made at many places. In a recent letter from Mr. S. W. Tillinghast, superintendent of the water works at Fayetteville, N. C., he describes a similar joint made in the first pipe put down there about seventy years ago, but says that the tapered pipe was trimmed too close to the bore, and the other end not being reamed out enough, in some cases the water broke through. To fix these, wedges were driven in, which, he says, came out in twenty-five or fifty years.

Twelve feet lengths seem to have been the general lengths of the old hand made pipe, but some have been found as long as thirty feet.

The thickness of the shells varied from one to twelve inches. In the south, long leaf pine, that from which turpentine and rosin are obtained, was used.

In Philadelphia, New York, and in the New England states pine, spruce and oak were used. Pine seems to have been mostly used by the old makers, presumably on account of its lightness and superior durability.

In the United States, the oldest pipe about which I have been able to learn, was laid in Boston in 1652.

Another instance of old wooden pipe is told by Mr. J. B. Lyons, master mechanic of the Pennsylvania Iron Co., at Norway, Mich. In answer to an inquiry he writes: "The Canton Land and Improvement Company of Baltimore, was cutting down and grading the clay hills lying between Washington street and Patterson Park, in what is known as East Baltimore now. In the course of their work they unearthed a large spring house which had been entirely obliterated on the surface. The spring or reservoir was about 15 feet in diameter, and built of hard brick. From this spring reservoir were running pine logs from twelve to fourteen inches in diameter, bored out four inches in diameter, and were put together with what used to be called a 'spigot and faucet' joint, or one end tapered off and went in the end of the next log.

"They said that line of pipe carried water into the fort or garrison established shortly after Lord Baltimore settled there. The timber was perfectly sound. I don't recollect having seen a rotten log taken out, and I saw a great many of them. It was claimed at that time that they had been under ground over one hundred years. This happened about 1840."

A little pipe is still made by hand, but not enough to be of any commercial importance.

On account of the heavier pressures required, the old pump logs had to be put aside for lack of strength.

Since machinery for economically boring and banding it has been invented, wooden pipe is again largely used for water mains where heavy pressures are required.

The first marked improvement in the manufacture of wood pipe was the invention of the core auger by A. Wyckoff, which was patented July 12, 1859, and subsequent patents were issued to him March 12, 1861, and April 3, 1866. The most of the water pipe now made is known as Wyckoff pipe.

In boring a log with the core auger, most of the cores from the larger pipe can be rebored for smaller pipe. A study of the old pipe laid indicated a number of improvements in the manufacturing to produce a suitable pipe for the increasing demands for better service. In the early pipe laid, as every-

where, it was noticed that the sap wood was perishable and ought to be removed. The old joints were so crudely made that it was difficult to hold water under very heavy pressures, and as heavier pressures were demanded and used, banding first of wrought iron, and later of steel was used to strengthen the wood shells. At present in manufacturing wooden pipe, white pine is used almost exclusively.

The log is first put in a lathe where all the sap wood is turned off, leaving it smooth and even. It is next put into a machine and bored with a core auger, leaving a shell two inches thick. It is then placed in a drying room, then taken to the bander, which is a machine for winding the bands on the shell spirally. The bander is provided with an automatic brake which holds the bands in such a manner that they are applied to the shell under a great tension and pressed tightly into the surface of the shell. At each end of the pipe the steel bands are wound double as a precaution to prevent splitting when the pipe is being driven together in laying it in trenches.

The weight of the bands and their distance apart determine the strength of the pipe.

When removed from the bander a mortice is bored into each end of the pipe 4 inches deep and half of the shell is removed. The mortises are bored to receive the connecting thimble, which is a short piece of pipe eight inches long, made of seasoned white pine with the same internal diameter as the pipe it connects, and the outside diameter one-eighth of an inch larger diameter than the mortise. When the thimbles are driven into the mortises they are compressed to the diameter of the mortise which makes the joint complete without the use of any packing substance or calking—only common labor being employed in laying it.

Before the thimble is driven in the mortise the pipe is tested to the greatest hydraulic pressure it is designed to be used under; then it is put upon rollers which work in a hot bath of melted asphaltum where the entire outside of the pipe is covered with asphaltum cement to the thickness of about one-eighth of an inch. Before the asphaltum cools the pipe is rolled on a bed of sawdust. The coat of sawdust being applied for the purpose of preventing pipe from sticking together in shipping,

and preventing the sun's rays from softening the asphaltum in very warm days.

A thimble is then driven in one end of the pipe. This completes the pipe at the factories.

In laying the pipe the thimble of the piece about to be laid is placed so as to enter easily into the mortise of the piece already laid.

A neat block, turned to fit into the mortise and the end of the pipe, which is provided with a suitable handle for holding it to place, is put into the end of the pipe to strike against to prevent the pipe from being bruised while being driven together. The driving ram is a piece of hardwood log about 10 inches in diameter and 3 feet 6 inches long, with a band of $\frac{1}{2}$ x 1 inch iron on each end. A pick handle driven at an angle of about 20 degrees into one end and a staple with a ring put in about 16 inches from the other end completes it. A rope is tied into the ring and fastened around a pole which has been laid across the top of the trench, allowing the ram to swing clear of the bottom of the trench. In this manner a laborer can strike a blow of great force and can drive several lengths of the smaller pipe together at a time. The pipe is driven up tight to cover the thimbles. When this is done the pipe is ready for use.

For street crossings and connections with hydrants, short cast iron crosses of the same diameter as the mortise in the pipe and tees are used with mortise bored smoothly into the bells. The bells of the hydrants and valves are made to fit the thimbles in the same manner.

There is a pipe made in California of red wood staves and fastened together with round iron bands; and another pipe made in the east of white pine staves, covered with sheet steel, but with these the writer has no personal experience. Most of the wood pipe used has been made substantially as described above.

Wooden pipe is extensively used for a variety of purposes, the most prominent of which is in water works. As the pipe is made to stand various pressures from 40 pounds per square inch up, some very desirable economies can be carried out in laying a pipe in a gravity system of water works, and in placing

water columns in mines, by using heavy pressure pipes at the bottom and light pressure pipes at the top.

Perhaps the greatest point of practical value for water works purposes are the elastic qualities of the Improved Wyckoff Water Pipe. A few cases cited may be of interest. A year ago this winter, a short piece of pipe line about 1500 feet was laid through some clay ground when the thermometer stood about zero. When the backfilling was done the excavated material was frozen so that the trenches could only be filled with big chunks which left so many spaces that the cold air easily penetrated to the pipe and around it. This pipe was on a "dead end" which had no domestic taps so that there was no circulation at all. As a result of this exposure to the cold air and no circulation, the water in the pipe froze solid and remained frozen until the frost came out of the ground in the spring. The tank pressure produces a constant pressure of 70 pounds per square inch, and a test pressure of from 130 to 140 pounds has been applied several times since without any signs of leaking.

Sometimes the excessive pressures brought on a main by pumps hammering or closing hydrants suddenly when under heavy pressures, will burst a main. Numerous instances have proven that even after a burst, in time of a fire, a good pressure can be maintained and the work of firemen continued. To see just how pipe would act under these circumstances, I made a test of a piece of 6 inch pipe called 160-pound pipe by the makers. A pressure was applied until 340 pounds was reached when a split in the wood shell about a foot long and one-sixteenth of an inch wide was produced letting out a sheet of water. The pressure was then gradually diminished to 120 pounds when the water ceased to come out in a stream, and dripped rapidly—possibly a quart in a minute escaping. At 100 pounds pressure a leakage was barely preceptible, and at 80 pounds no water escaped at all. This feature of the Wyckoff pipe makes it of particular value in the smaller towns where the pumping engines are used to produce the force and pressure for fire streams without the use of fire engines. The wood splits to relieve the pressure, but the bands are not affected, they being spirally applied will close the wood back tightly to

place, no piece or chunk being forced out to make it necessary to cut off that part of the main which is furnishing the fire streams. In this connection I might mention a case where a piece of pipe in a line under a tank pressure of 95 to 100 pounds had a band broken on account of a flaw in the iron. The leak had been running nearly two days before the superintendent's attention was called to it. Water came to the surface but not enough escaped to damage any of the adjacent property, or to interfere with the city's fire protection.

When it becomes necessary to raise or lower water mains on account of changing the grades of streets or shifting it in trenches, this work can be done with Wyckoff pipe while under pressure, without disturbing the joints. In river crossings where the pipe line is carried over the stream by a bridge, the joints are not affected by the vibrations of the bridge or of the pipe line.

Proprietors of mineral springs have found that the chemical action of mineral waters containing sulphates would form soluable compounds which, in time would eat away iron pipe so much as to interfere with its strength, and waters containing carbonates would form concretions filling up iron pipe and reducing its capacity, besides robbing the waters of their peculiar properties.

To prevent such action on iron pipe, in ordinary water works and works for mineral waters, linings have been devised of cement, porcelain and glass, also paper, but nothing yet has been found more serviceable or economical than wood. None of these minerals have any chemical action on the wood, and water passes through the wooden water mains and is delivered in the same chemical state in which it is received.

For the same reason, much of the Wyckoff pipe is used in coal mines in pumping water containing some form of sulphur.

Tanners and manufacturers having occasion to pump liquids containing alkali and acids use wood pipe to good advantage.

Distillers use it for conducting hot slops to their cattle sheds finding that it is not affected by expansion and contraction. A line of about two miles for conducting hot slops has been in successful operation since 1882 at Walkerville, Ont.

Besides the uses of conducting liquids and water, wooden pipe with a heavier shell, 3 and 4 inches in thickness, is made for encasing steam and hot water pipe, used in conducting steam and hot water under ground.

Wood being a nonconductor of heat makes it well adapted for this purpose. This steam pipe casing is made larger than the steam pipe it is to encase, leaving an air space between the steam pipe and the wood pipe. This reduces loss from condensation and radiation to a minimum, and has made it possible for a number of companies to operate successfully plants for the sale of steam for heat and power from a central station.

This property of being a nonconductor of heat reduces to a minimum the possibility of water pipe freezing.

Most of the government and many of the state fisheries use wooden water pipes for conducting water used in their hatcheries to preserve its purity.

Wooden pipe is also being used for underground wire conduits. Over 100 miles of it were used for wire conduits at Jackson Park, Chicago, during the World's Fair, and several hundred miles has been put in Philadelphia and is extensively used now.

It is used quite extensively for gas pipe. This bright chip of pine taken two years ago from a gas pipe which had been in use twenty years, at Dixon, Ill., shows how well the pipe lasts for that purpose. A recent letter from Mr. C. H. Raynor, superintendent of the Adrian (Mich.) Gas Company, says that a few weeks before while a sewer was being put in he had a good opportunity to examine the wooden gas main which had been down twenty-two years, and found it in good sound condition with no smell of gas in the ditches. A very similar statement is made by Mr. J. C. Sterling, secretary of the Monroe (Mich.) Gas Light Company, about their gas pipe which has been in use twenty years.

Time has tested the durability of wood in water pipes when it was made with less care and under less favorable circumstances than now.

The following extract from the proceedings of the Engineer's Club of Philadelphia, volume IV, No. 2, May, 1884, is not only

interesting in showing the early construction, but also the lasting qualities of wood under these conditions:

"Major C. Henry Roney exhibited a section of 4 inch wooden water pipe and joint found about two feet below the surface while excavating a trench for the conduit of the Philadelphia Sectional Electric Underground Company on Chestnut street, between Fourth and Fifth, and described those which had been found on Chestnut and Market streets during the progress of the work. These are interesting as showing the durability of such pipes and connections under the conditions to which they have been subjected.

"The section shown was of spruce, originally about 14 inches in diameter at the larger end, and somewhat smaller at the other, having a wrought iron band about 1½ inches wide, ⅜ inches thick at one side and tapering to a thin edge at the other, so that it could be driven on or into the end of the log near the outer circumference; a piece of iron pipe 4 inches internal diameter and about 12 inches long, tapering to a thin edge at each end, served to connect the ends of two adjoining logs, which were driven over it end to end and prevented from splitting by the iron bands around the ends of the logs. In some cases no interior iron coupling was used; one log was tapered at the end and driven into the next one which was prevented from splitting by the exterior iron band.

"The four inch pipes so far found were of yellow pine, spruce and oak, of about twelve foot lengths and from 12 to 24 inches in diameter and supposed to have been laid between 1795 and 1805; the depths at which they were found varied from two to eight feet below the surface of the street.

"The outer bark and heart wood of the spruce logs were generally sound, while the inner bark and sapwood were decayed, except where the soil was dry, gravelly or porous, when the greater part of the wood was decayed, and the iron badly corroded. A specimen of red oak from a log adjoining the spruce one shown was decayed on the under side, but other portions looked nearly as fresh as if recently laid. The portions in contact with the iron coupling and band were blue black from the action of the tannic and gallic acids on the iron. The 6 inch pipes were much larger, in some cases nearly 30 inches external diameter, in most instances the iron couplings and bands were but slightly corroded, the amount of the corrosion seemed, however, to depend very much upon the soil in which they were found—where the wood was decayed the iron seemed to have rusted more than where the wood was well preserved from access of air and probably from the same causes. In some instances where the logs were of very large diameter they had been reduced at the ends to fit the bands, but in most cases the bands were driven into the end of the logs without any reduction of diameter."

In this case of the Philadelphia pipe, where the heart wood was generally sound, the pipe had been buried 80 to 90 years. The pipe of course had not been used for a great many years.

It is more than probable that air currents passed through this pipe for many years after it had been discontinued as a water main, and in porous soils and outlet, at such places rusted the iron and decayed the wood as stated by Mr. Roney.

An examination of this piece of Wyckoff pipe is interesting as showing the preserving qualities of asphaltum for both iron and wood in porous ground. It was taken up in Quinnesec, Michigan, last August where it had been buried less than two feet below the surface for a period of ten years in a very porous sandy soil. I made a close examination of about 1,000 feet of Wyckoff pipe, which was then taken up and relaid, without finding any effects of rust in the iron or decomposition in the pine. The thimbles which were broken in taking it up had a bright, fresh look, and this cut in the shell shows the wood to be bright and fresh. Where the asphaltum is knocked off the iron is shown to be entirely preserved.

Trautwine in his Engineer's pocketbook speaks of pipe of bored yellow pine logs, which had been laid between 50 and 60 years in Philadelphia, being taken up and relaid for use around factories.

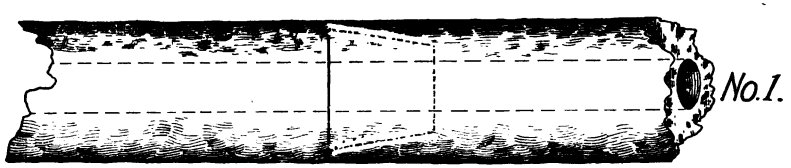
The Manual of American Water Works for 1888 in the history of the Lynchburg, Virginia, water works, speaking of the old pump logs says: "In 1828 all but two lengths of the wooden pipes were taken up and these were found while making sewer excavations in 1869. They were all preserved and were secured by city engineer Forsberg, but were stolen by negroes for fuel." As these old works were mostly built in 1811 these pieces had been in use 17 years, and laid unused in the ground for 41 years more. It indicates again something of the lasting qualities of wood when used as a water conduit.

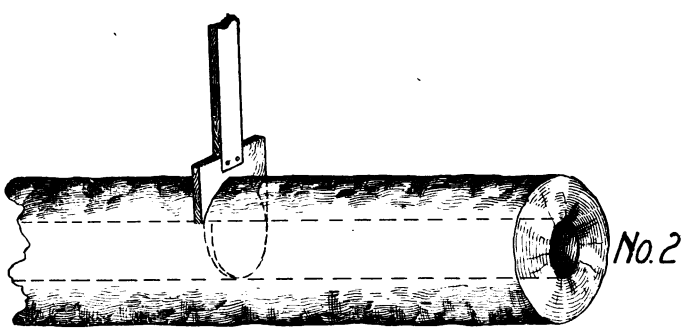
A few years ago a few sections of old pump logs which were originally laid by the Aqueduct Company to bring water from Jamaica Pond into Boston in 1796, were excavated and exhibited in the city and attracted considerable attention on account of the remarkably good state of preservation. The wood used was pitch pine.

This piece of wood is a section of the old pipe put in New York City by the Manhattan Company which was organized in the year 1798 by Aaron Burr. This piece of pipe was excavated

in March, 1893, and was sent to me by Major R. P. Tomassek, engineer in charge of the excavations for the 3d Avenue Cable R. R. From a letter addressed by him to me, dated at New York, April 20, 1893, the following extract is taken.

"In the course of excavation of the road bed of the 3d Avenue Cable R. R. we found on Park Row, opposite the Brooklyn Bridge entrance; at the depth of 42 inches, a wood water pipe of 14 inches to 16 inches outside diameter and 4 inches to 6 inches bore running for the length of 80 feet, in sections from 10 feet to 12 feet lengths. The connections of the sections being made as per sketch No. 1. One branch at a right angle was discovered, leading towards Tyron Row, with a shut off on the first length. The length of this branch I don't know as it run outside the line of our excavation, and therefore I had no interest in following it. The shut off was constructed by sawing partly in the log and inserting a flat plate of iron which was fastened on a lever, and of the shape as indicated in sketch No. 2. The material used was Norway pine and was furnished in the year 1800 by a farmer named Dobson, Oswego, N. Y., and the boring was done by hand. I express to you a section of that pipe, as I preserved several of them."





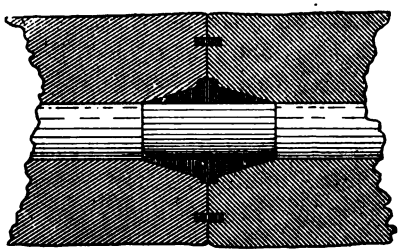
An inspection of the piece will show all but a small part of the sap wood to be well preserved. The check marks now observed have appeared by exposure to warm air in the office since it came into my possession.

These old pipes of the Manhattan Company have laid unused since 1842, at which time it discontinued the water service.

Although the wood is well preserved and sound it does not have such a fresh look as this piece of wood from a piece of pipe which was recently taken up at Fayetteville, N. C., by Mr. S. W. Tillinghast, superintendent of the water works. He writes that this piece is at least 70 years old. The works were built 70 years ago and have been in constant use since. This piece is now as bright and sound as if taken from timber recently cut down.

The most of the logs in the Fayetteville works were of long leaf pine, bored by hand, put in the ground without coating. Mr. Tillinghast has been identified with these works for ten years and says he has had ample opportunity to examine the pipe and with the exception of the weak place where the pipe was tapered too near to the bore, as mentioned before, he found the majority of the pipe in as good condition as it ever was.

Mr. Geo. S. Pierson, M. Am. Soc. C. E. of Kalamazoo, Mich., related a case of finding some old pump logs well preserved at Schenectady, N. Y., while constructing a sewer there in 1884. They were connected by a piece of composition metal and dowel pins as shown in the sketch.



The records of these old pipe were lost and their age can only be conjectured. As Schenectady was settled in 1684 and incorporated a borough in 1765, they are supposed to have been some of the earliest pipe used in the country.

Portsmouth, N. H., has had works of the same character in use since 1798, and Drewsville, N. H., since 1804. Instances of the durability of wood under similar circumstances might be multiplied.

The use of wooden penstocks and flumes in the manufacturing districts of the east, and the use of cribs and piling in water

and under heavy structures on land all testify to the durability of wood when kept wet and buried.

It is a well known fact to engineers and observant people that wood which is constantly kept wet, or constantly dry will last for an indefinite period.

In order to find out what effect the action of water had upon the surface of the band which is in contact with the shell of the pipe, Mr. M. F. Wilcox, of Bay City, Mich., placed a piece of pipe with an uncoated band in a tank of brine where it was left for a period of two years. When it was taken out it was found that the action of the salt water had corroded badly the outer surface of the iron. The band was removed carefully from the pipe and it was found that the brine had produced no changes on the surface which was in contact with the wood.

The greatest difficulty in preparing wooden water mains has been to preserve the bands from the action of acids and moisture in the soil. This has been effectually accomplished by the use of asphaltum for a coating, which is practically indestructible.

Wooden pipe as it is now made has proved its strength and durability, and the majority of towns, and companies which have built their water works with it are pleased with its service, and make their extensions with it.

Steam pipe casing has not yet had a full test, but after 16 years use it is doing its work as well as ever.

THE PRESIDENT: The city of Grand Rapids has had a pretty large experience in the use of wooden pipes for water pipe, and their experience on the whole, has not been favorable to the use of this kind of pipe. It was introduced there in the year 1874, and the board of public works laid some thirty-two miles of pipe—advertised for proposals—any kind of pipe. They received proposals for cast iron, Wyckoff and cement iron pipe, such as at that time was largely in use in the New England states. The cement pipe had been recommended by the engineers, but I looked into the matter myself and did not like it. I did not believe it could be made durable in all kinds of soil, and I protested against its use. That left a choice between cast iron and Wyckoff. The difference in price at that time was so great that the board, having only a limited amount of

money, at its command determined to use the wooden pipe, and they put in some twelve miles.

It answered expectation in some respects. It was very difficult to injure it by frost. Pipes in which the water froze solid were not injured, and it was excellent to resist the water action. But either from an innate defect of the system or from poor workmanship, the joints were affected. I think at that time they made these thimbles shorter than now—at that time only six inches long—and I proposed at that time to make the thimbles longer, and also to put a little rim of thin iron outside of the thimble, so when they put the pieces together that rim would prevent the joint from leaking. They afterward adopted a longer thimble. Our works went in, in that way, and before long, we had trouble with the joints. They commenced to leak and after a time they became so troublesome that the city determined to get rid of them, and I believe now, there is none of that pipe left.

MR. SKEELS: I think it has all been taken up, none of it now in use.

THE PRESIDENT: They also laid a lot of logs on high ground that answered a good purpose for some time, but afterwards they put up a stand pipe and they have all been taken out, and iron pipe substituted.

They also used, for carrying the water from the collecting basin down to the pumping works, about a quarter of a mile of pipe, made of staves, wrapped with bands of iron. The gentleman who was superintendent of the board had had some experience, and he devised a plan for making the pipes taper, and driving the bands along from one end. That proved a poor system. I am satisfied now, that if they had used bands with secure bolts and ends, that method would have been all right. This method of construction however proved poor, and they took that pipe out and replaced it. So far as I know now, the entire system of wooden pipes has been taken out.

MR. WELLS: These short thimbles have been found objectionable. Another cause of leaks is where the workmen do not shove them up tightly. The work of careless men has caused much trouble; I have had wooden pipe under as high a pressure as 170 lbs. per square inch and discovered no sign of leak; a

number of improvements at the joints have been made—this extra binding—and making the thimble larger than the mortise; putting the thimble in, of seasoned pine, makes it even tighter than when first driven in, and makes a very successful joint.

Another thing, the early makers of wooden pipe had a very much easier market, than since cast iron has become so much cheaper, and pine has become dearer; care is being used in inspecting what is used now. I looked up some of this Grand Rapids pipe, and a lot was sent out without being put through the testing machine at all, by the men who were then making it.

I have talked with some of the men who were engaged in digging up the pipe who told me that the most of it was in good condition. A large quantity of pipe which had been taken out at Grand Rapids was purchased by the State for one of the fish hatcheries and is now being successfully used there.

Pipe laid at Bay City and other places about the same time that pipe was laid in Grand Rapids, is at this time giving good satisfaction.

THE PRESIDENT: The thimbles then sent to Grand Rapids, shrunk at the joints and a great many defective ones were overlooked and slipped in.

In a recent paper in regard to the pipe of the Denver water works, where red wood was employed, the work is peculiar. They let the staves slip by each other, so that there were no joints the length of the pipe, and they are banded with straps.

MR. HODGMAN: It would seem that the wooden pipe was taken out at Grand Rapids because the joints failed. They were not strong enough to stand the pressure. If they could not be made strong enough it would be a serious objection to the use of wooden pipe under pressure but I understand that objection has been entirely overcome.

MR. WELLS: Any of the makers now, will make guarantee of the strength and keeping in repair—to keep ahead of competitors—they guarantee strength and durability, and place themselves under bonds to keep up repairs.

Q. Isn't there a certain amount of difficulty in keeping up connections?

MR. WELLS: Connections for private consumption?

Q. Any sort of lateral connection?

MR. WELLS: Those are made with castings. Some makers have a special, that holds pressure up to 80 lbs.—beyond that, they use cast iron.

MR. TEED: I have had some experience that comes quite handy. When our pipe was laid, the man who laid it, in order to make it as cheap as possible, followed the lay of the land. This fall I was laying a sewer, and could not avoid his pipe, so I put the sewer straight up the street, and I came to one place where the pipe followed along the ditch, 150 feet. The man who was laying the pipe, had profound disrespect for wooden pipe, and hated it so that he ignored it entirely, and the consequence was, he dug the ditch right down and would leave little chinks of dirt, or set a little stake under the pipe and lay the sewer pipe, and if the water pipe was in the way, he would shove it over, and then back again; it didn't leak very much, and when they got through, they put the water pipe where it belonged, and went away.

One time, I remember this pipe laid right along on top of the ground for quite a distance and they drove over it with the wagons, and once in a while would hit it, and push it about. In that case, they had to put a plug in. When they got the street graded, a man came along and let the pipe down, and it worked all right, and is there yet.

GOOD ROADS.—THE WAYS AND MEANS FOR THEIR PROCUREMENT.

JOHN J. WATKINS.

This subject has been thoroughly ventilated in the past; the necessity for them fully admitted, the desirability duly acknowledged, and when made their advent fully appreciated by all. The wind work as in all great enterprises must of necessits first be done, and we think a mighty effort in this direction has been fully exemplified by the large number of articles furnished the press generally, as well as the invocation of aid by the various societies throughout the length and breadth of

the land, whether the cause was related to the subject matter of their general proceedings or not.

The cause has elicited from the president, cabinet, heads of departments, governors and officials of all grades both national and state their views on this important subject. Tom, Dick and Harry, Peter, John and James have all had their say; the press that mighty engine for moving the world of action has volunteered its powerful aid, and yet where are we today? Aside from the few suggestions for special aid by the general government or the states individually the burden of all the songs sung by this great host of ardent desirers for this elysium of travel has reverted right back to the husbandman as the only source from whose labors these pleasurable delights are to flow. Is it not enough that their labor should be expended for their own convenience and the easement of the neighborhood generally, but many persons would saddle upon these brawny shouldered and hard handed class of toilers, the yet finer work of planing down the rough places and sand papering all surfaces of the common roads that the more elegant equipages may gently roll over the glassy smoothness affording ecstatic enjoyment to the pleasurers within, or affording to the wheelmen that fancied recreation of flying as it were over a smooth road bed with a velocity exceeded only by the ice boat as it speeds over the surface of the frozen waters.

Think not that my strictures arise from any less desire for good roads than that of the many other earnest advocates, but I desire to lay the ax at the root of the tree of error in saddling the burden of building and maintenance of the tens of thousands miles of highway upon that portion of the population who are rural dwellers.

Something for nothing is the quest of many, especially of the ease loving ones, just as the Bedouins of the prairies are ever seeking the greenest of pastures for their horses and a nice camping ground for themselves with plenty of firewood thrown in, and potatoes and corn from the neighboring fields for the taking. Yes, something for nothing this is the acme of their nomadic life.

I do not know that I shall be able in presenting this paper to strike the cords vibrating in the general mind in relation to

good roads, because of the innovation of novel methods which shall be presented, they may not commend themselves to the public pulse, yet imbued as I am with the justness of the plans to be offered, I shall present them without misgivings as to the final outcome, and to this end it is desirable that all shall lay aside for the time being their preconceived notions and attend without prejudice or partiality to the unfolding of the scheme that shall be presented for the making and maintenance of a better highway system than we at present enjoy. In the old toll gate system tribute was paid to but a single line, and other lines of travel were left without aid and generally without care. If good roads are to be maintained a fund must be created and supplied from some source that will be sufficient for the demands upon it, if not by grant, or tolls, then by tax; all taxes seem to many people to be objectionable and any additional one to those already borne is promptly met with displeasure, if not proclaimed obnoxious, and yet the fair-minded citizen is perfectly aware that taxes are as necessary to the life of a community as food and raiment is to the body; but it behooves us all to see that taxes are apportioned to all as per benefits to be derived from their expenditure. Is it not the law of all privileges that those enjoying them shall pay for the same (if able)?

The old adage though trite is not without its force and instruction, "Those that dance must pay the fiddler." Those then that use the roads must pay for them. Now comes in the question, how can those who use the roads be made to pay their proportion for the use of them? Good roads can be maintained, after the usual highway tax has been expended, in four ways:

1. By special appropriation by the general government.

2. By special appropriation by the state the same as for schools.

3. By a general wheel tax; a tax should be levied against all persons who own and keep a horse or other work animal, or a vehicle of any kind for use upon the highway, either for pleasure, business or profit, and duplicate for every additional team and vehicle, let it be a buggy or carriage of any kind, cart, wagon, omnibus, hack, express, truck or thresher, nothing in

the shape of a vehicle should be allowed to escape this wheel tax.

It should when collected be appropriated upon the leading lines of highway, in this way the cities and villages would contribute their proportion for the maintenance of the public roads, which every one having a buggy, cart, dray or wagon uses more or less. This tax should be in addition to the general property tax for highway purposes.

The gross injustice and I might say iniquity of the present mode of maintaining highways has been made apparent to the writer by observing the heavy freighting teams, the sand haulers, the brick haulers, the rock haulers using the country roads for the transportation of their loads without contributing one cent for their construction or maintnance, and these roads built and maintained by the owners of the land and some of them not even a laid out road at that or otherwise created by law. Now each one of these haulers earn more money in the course of the year than any farmer around gathers from his farm, yet they furnish the easement. Verily something for nothing! The farmers have to furnish the ways and means for these money getters without recompense.

I doubt if a more equitable scheme can be devised for the maintenance of highways than the *wheel tax*, then every man pays only a legitimate proportion for what he uses and wears out, and this is strictly just.

4. Another mode for improving highways is for cities and villages to raise by contribution a fund to be applied on such country highways leading to such cities and villages, to be divided among the different sections of such roads in proportion to the amount of travel sustained, only after the ordinary highway tax has been properly expended and upon the condition that the localities donate in excess of the highway tax an amount of labor equal to twice or thrice the money received from the city or village. This has in times past stimulated the farmers to contribute heavily when aid was given to their road, and what has been done in the past with success, can be done again with at least an equal certainty of attainment of the same ends.

In view of the foregoing, therefore, the ways and means for

the attainment of good roads outside of any special appropriations by government or state, lies in the highway tax as now, or hereafter may be, assessed, a special wheel tax on all vehicles kept for pleasure, business or profit, and a special tax on all animals kept for work or pleasure on the highways, and a gratuity from cities and villages (if attainable) to direct lines of highways upon terms to be agreed upon. These methods should they be adopted could be made ample to put our roads in such condition as all would desire they should be, but it is possible that we shall all trudge along in the old slough of despond at the same pace as in the past till all who use the roads are compelled to pay a proper share for their use.

As the Romans put it "All roads lead to Rome." This was only so after the Roman people had made their splendid highways in the country to lead to and from the city of their pride, but this work was all done under the supervision of competent engineers; so we think that any work that is worth doing, is worth doing well and that the entire highway tax as it is or as it may be augmented should be expended under competent engineers in each county with aids in every town.

Guthrie, O., Dec. 28, '93.

THE PRESIDENT: Any comments on this paper, gentlemen?

MR. HODGMAN: There is one matter, as to a certain class of people wanting the farmers to pay the entire expense of the road. The new road law of Michigan, wherever adopted, instead of adding to the farmer's tax, makes the cities and villages pay the greater proportion of the tax. I protest most earnestly against the statement so commonly made by farmers that other people want expensive roads built at their expense. It has not a word of truth in it.

THE PRESIDENT: It seems to me that, under the new provision of our constitution, there need be no such idea; the people of the country can make the residents of the city pay the large proportion.

The idea of the wheel tax does not strike me favorably; the man who keeps a carriage, and uses it only once a week or month, would have to pay as much as the one who drives once a day; perhaps the fair way would be to levy toll, as on toll roads.

Does anyone know how many counties have adopted the road system since the change was made?

MR. HODGMAN: Some three or four, I think.

THE PRESIDENT: I think this society is instrumental, in some degree, in this change. I am afraid, that as it is left optional with the board of supervisor, that not many will adopt it.

MR. STRONG: No one will dispute the rule that the tax should be in proportion to the benefits; but if I owned a horse and carriage, and needed to build a house of brick, perhaps I could build it a little cheaper if I could haul the materials over a good road; so with other things. It is my opinion that the general tax is not far from the right thing. If the farmers of this State should throw away this opportunity, as they are very eager to do, will they have the opportunity again? Perhaps they will wonder, at the end of years to come, why the people of the cities and villages were so foolish as to propose to build a half, or more than a half, of the country roads for the farmers. The reason I say half, or more than a half, is because this amendment is carried, in spite of the fears of everyone, showing that the majority in the State want these roads at the present time. Heretofore the farmers have had to build their roads, or go without them; now other people are willing, and more than willing, to help the farmers.

If we are ever going to gravel our roads, the material must come from somewhere. We should locate gravel lands for road purposes, and pay the market price for same; and if they cannot be bought for that, let the highway commissioner have the right and power to locate the places. With good gravel, the farmers themselves could do a great deal, and if the farmers wish to preserve the tax in their own hands, it is a wise thing for them to show what disposition they will make of it. Otherwise the tax will go out of their hands, as in the state of New York.

There is another matter, that of grades. The sooner we can have a system of grades, the more we will save of the work that has been, or is to be done.

REPORT OF COMMITTEE ON ROAD SPECIFICATIONS.

J. J. GRANVILLE, *Chairman.*

To the President and Members of the Michigan Engineering Society:

GENTLEMEN—Your committee to whom was referred the matter of formulating general specifications for the construction of country highways, find our task indeed a hard one when we reflect on the great variety of soils and conditions we have to contend with; and although the geological condition and diversity of soils found in Michigan are, on the whole, favorable for the construction and maintenance of common roads—"the people's highway"—the practical economist and skillful engineer, who have given the subject careful study, find much to condemn, on viewing the slip-shod, wasteful methods now pursued, both in the construction and care of country roads.

We are asked to make a specification for the betterment of spring and fall "muddy lanes," and to convert them into good roads. How shall we do it?

We are not as skillful as the dealer in patent medicine, who makes a specification for one bottle and the result is a panacea. We must first know the nature of the soil, the character of the traffic, and the kind of road wanted or attainable, with the means at our command, and these in all cases govern the specifications.

In our partially settled country, with common roads on every side of each square mile of territory, the mileage, as compared with the population, is so great that perfection of drainage and surface cannot be obtained for some years to come.

All that we can do under present conditions is to educate the people, and show them on what lines, and in what manner to lay the foundation for good roads as population develops, without waste of capital and labor, so that what is done in the formation of the road-bed and drainage of the same, may not be utterly wasted.

Every practical, observant man who has paid any attention to the construction and maintenance of common roads where the

soil is clay, will assent to the truth of this statement, viz., to tear up and reform an old road-bed, and change the slope and lines of the ditches, after it is once constructed and consolidated by years of traffic, requires more money, time and labor than is necessary to make a new road, and a comparatively good one, on the same soil where none existed. This being a recognized fact, "what fools we mortals be," going on year after year pretending to construct roads, without any plan or principle, without any recognized width for road-ways and ditches, and without any foundation. We say foundation, because in anything but sandy or gravelly soil, the formation of the road-bed is almost as important as the drainage.

The construction and use of highways, or roads of whatever description, are dependent upon three principal factors:

1. LOCATION.
2. CONSTRUCTION.
3. MAINTENANCE.

Under these three heads we desire to make a few suggestions preliminary to submitting our specifications.

Without entering too much into detail, through lack of time, ability, and regard for the patience of the society, we feel as though we should dwell somewhat upon each subject, and shall consider them in the order mentioned.

LOCATION.

It is assumed that the proper authorities have determined that a road shall be constructed between certain points, and have engaged an engineer (a competent one), to locate, prepare plans, specifications, etc., and superintend construction of same.

The first consideration which confronts the engineer is the proper location of the road; although too often, and in fact, almost invariably in this enlightened commonwealth, the location is restricted to the section or quarter lines, without regard to physical features, and the engineer instructed to follow the said lines. Assuming, however, that the location is left to the judgment of the engineer, he will make his location with due regard to traffic, grades and cost, and the convenience and necessities of the tributary community.

In the location of the line, all unnecessary ascents and descents should be avoided, and changes in the alignment should be made by curves, having as long a radius as possible, making the mimimum forty to fifty feet, although it may be necessary in extreme cases to reduce even this.

Very frequently, by a slight deviation of the line, abrubt hills can be avoided, and thus a saving of time, labor, and money, and a great reduction of grades be effected. Instances have been noted where by deviating the road less than 100 feet from a straight line, a steep bluff with grades of one in five to one in ten, could have been avoided and a nearly level grade secured. But the section line must be adhered to, regardless of hills, or holes, labor, money, or convenience, and the ever patient farmer compelled to drag his produce over such grades, when had proper intelligence been used in the location, he would have been able to haul four or five times as much, with the same expenditure of labor, and a large saving of immorality.

This brings us to a consideration of traffic, and its character must be considered, whether light or heavy. We must also consider its future growth, for it must be remembered we are not building for today but for tomorrow.

Grades.—After the location has been made, and the plan and profile prepared, the grade line should be fixed with a view of reducing the work to the minimum, at the same time keeping gradient within proper limits.

A level grade, of course, is the desideratum, although it is claimed by experience that a road with undulating grades is preferable to a long, level or uniform slope, as affording on the down grades a slight measure of relief to the draft animal, which it does not experience on a continuous grade; but Gillmore terms this idea as a "mere popular error, unable to withstand the test of intelligent investigation."

As a maximum grade, he recommends one in thirty. Trautwine on the same subject says: "On a turnpike road—about one in thirty-five—is the greatest slope that should be given, to allow horses to trot down rapidly with safety."

The following table, as showing the amount of work a horse can do, is taken from Herschel's "Science of Road-making,"

and is based on calling the load a horse will pull on a level, one, then:—

On a grade of			1	in	100	a horse can	pull	0.90.
"	"	"	1	"	50	"	"	0.81.
"	"	"	1	"	44	"	"	0.75.
"	"	"	1	"	40	"	"	0.72.
"	"	"	1	"	30	"	"	0.64.
"	"	"	1	"	26	"	"	0.54.
"	"	"	1	"	24	"	"	0.50.
"	"	"	1	"	20	"	"	0.40.
"	"	"	1	"	10	"	"	0.25.

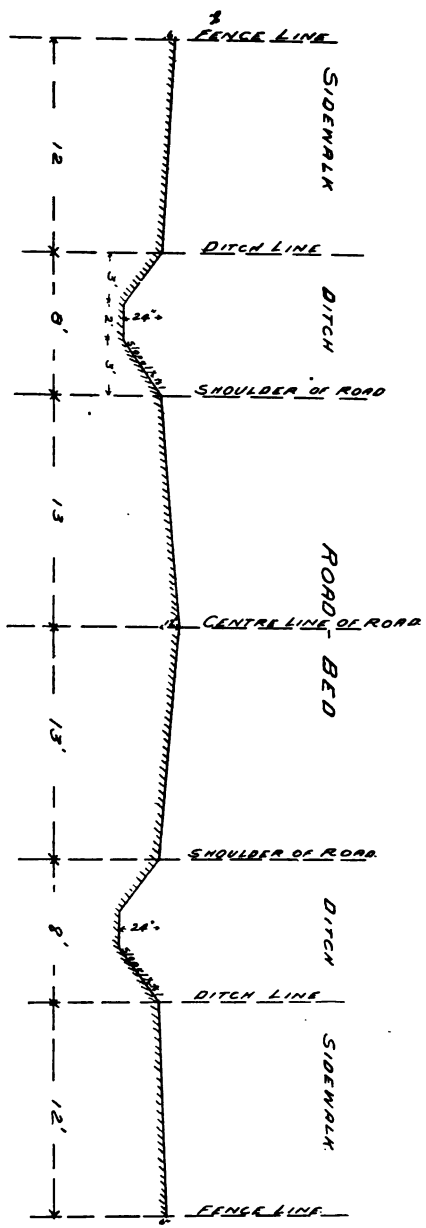
The determination of the gradients, however, will depend very materially upon the conditions with which the engineer is surrounded, such as traffic, character of material to be handled, etc., and very largely upon the amount of money at his disposal. It will also depend materially upon the character of the road surface to be constructed.

The resistance to motion, or the force required to move vehicles on different kinds of roads, is well shown by the experiments of Morin, made in 1838–41, and which appear to have been made with a degree of care and accuracy leaving nothing more to be desired. The following table is an extract from his results, and gives the fraction of the weight of the vehicle and load which is required to move them on a level road:—

Character of Road.	Character of Vehicle.					
	Two-wheeled carts.	Truck, 4 wheels, 3 & 4 horses.	4 horse stage coach on springs.		2 horse carriages, body on springs.	
Firm soils, covered with gravel, 4'' to 6'' deep	1/12	1/9	1/8		1/8	
Firm embankments covered with gravel 1½'' to 1½'' deep	1/18	1/11	1/10		1/10	
Earth embankments in very good condition	1/41	1/29	1/26		1/26	
Bridge flooring of thick oak plank	1/70	1/46	1/41		1/42	
Broken Stone Roads,			Walk.	Trot.	Walk.	Trot.
In very good condition, very dry, compact and even	1/75	1/54	1/48	1/41	1/49	1/42
A little moist or dusty	1/58	1/38	1/34	1/27	1/34	1/27
Firm, but with ruts or mud	1/38	1/24	1/21	1/18	1/22	1/19
Very bad, ruts 4'' to 4½'' deep, thick mud	1/19	1/14	1/13	1/10	1/12	1/10
Good Pavement: Dry	1/90	1/65	1/57	1/48	1/59	1/49
Good Pavement: Covered with mud	1/69	1/50	1/44	1/38	1/45	1/34

From experiments made with the dynamometer attached to a wagon moving slowly on a level, the following results were derived; the results being, force required to move one ton of 2,240 pounds:—

1. On best stone track-ways, 12½ lbs.
2. A good plank road, 32 to 50 lbs.
3. On a cubical block pavement, 32 to 33 lbs.
4. A macadamized road of broken stones, 65 lbs.
5. A Telford road made with six inches of broken stone of great hardness, laid on a foundation of large stones set as a pavement, 46 lbs.
6. A road covered with six inches of broken stone laid on concrete foundation, 46 lbs.
7. A road made with a thick coating of gravel laid on earth, 140 to 147 lbs.
8 A common earth road, 200 lbs.


FENCE LINE
SIDEWALK
12
DITCH LINE
DITCH
8'
3'
2'
3'
26°
SHOULDER OF ROAD
13
ROAD BED
CENTRE LINE OF ROAD
13'
SHOULDER OF ROAD
DITCH
8'
26°
DITCH LINE
SIDEWALK
12'
FENCE LINE

Having established the grades after a full and careful consideration of the various features, a cross section of the completed road should be prepared, and your committee submit the annexed diagram, not believing in their wisdom that it is the best and is incapable of improvement, but it is submitted with a view of securing a uniformity of widths and of construction. Of course under varying conditions this form of cross section must be modified, but having in mind the construction of a road in a clay soil, we submit this form for your criticism and approval or modification, believing that a uniformity of construction where possible, is a desirable thing.

We note in Herschel's "Science of Road Making" that, "To make a good road surface is a very simple operation after only it is once understood, and the fundamental principles thereof once comprehended, they can hardly be forgotten. Everything connected with the construction, the use, and maintenance of roads, was in times past, before the invention of railways, the subject of exact observations and experiments, many and varied in character. Old engineering works that treat of road making are on this account excellent reading on this subject at the present day, upon road construction no less than upon the need of better road legislation.

"Some, perhaps the most, of the evils we suffer in the shape of bad common roads, are merely the result, the necessary consequence of our bad systems of common road management, which are derived from our antiquated legislation upon that subject. Legislation of this kind has changed but little in a hundred years, and is producing the same evils today that it did a hundred years ago; hence it is explainable that the complaints concerning bad roads and bad road management, which we read in books of fifty and sixty years ago, sound to our astonished ears as though they had been written but yesterday."

See "Life of Telford," the great English road builder, a treatise on roads by Sir H. Parnell, 1833, and other works of earlier date.

Does the man or the community tolerating poor roads reflect at all? Are muddy roads and poor, exhausted horses pleasing objects to contemplate, and shall we go on for years maintain-

ing two over-worked and jaded cripples to execute work that one good horse would do on good roads, in half the time? How long shall inhumanity and barbarism rule the majority of mankind?

Let those who are capable of thinking on the subject arouse to action, and compel the laggard and drone to mend his ways. Let farmers and others reflect on this fact.

"On the whole, the community is supporting hundreds of horses to drag loads through holes that ought to be filled, over sand that should be hardened, through mud that ought not to be permitted to exist. We have the curse and misery of bad roads, and are actually and practically called upon to pay a premium for them. A road well built is easily kept in repair. A mile of good gravel or macadamized road is more easily supported" (Herschel) than half a dozen misused, crippled horses.

In considering the subject of construction, the consideration of the material upon which we must operate enters very largely into our calculations, and the means and manner of draining, formation of the cross section, etc., will vary with various soils.

"In gravelly soil all the materials that are needed for a good road are frequently on the spot; they only need sorting out and relaying. For this reason a common gravel seive often constitutes the principal instrument, the judicious use of which will make a good road out of a miserable string of ruts and cobbly elevations. It would be only necessary to sift out and separate the soil under the road to a sufficient depth into cobbles, coarse gravel, fine gravel and sand, then replace them in the order named, and with the proper thickness of layers of each, wet down and roll, and the result will be a good road."—*Herschel.* Will farmers take this hint?

In clay soils the method adopted for gravelly ones would be unsuitable. Here thorough drainage is of the first consideration, as it is in all road construction, though to a less degree in a soil of a porous than in one of a retentive nature. And so in considering construction we must first devise a thorough system of ditches, drains, culverts, bridges, etc.

Bear in mind, as a fundamental principle, that water is the greatest enemy with which a road has to contend, and with this principle always in view, plan for drainage accordingly.

It is better to err on the side of safety, and plan for ditches, drains, etc., of greater capacity than it is calculated will be required, than to construct them of a capacity totally inadequate for the requirements of an extraordinary storm.

Drainage is of two kinds, surface and sub-drainage. The first provides for the speedy removal of the storm water falling on the surface, and the latter, for such as may find its way into the soil. With the removal of the soil water, the danger from the action of frost is avoided, which, if allowed to act, disrupts and upheaves the surface of the road and leaves it in that condition, in the spring of the year, with which we are all so familiar.

Secure good, deep outlets for all drains; for the object of our drains is to dispose of the water as quickly as possible.

Construct culverts where needed for thorough drainage. Their size will depend upon the amount of water they may be expected to carry, and should be constructed of some imperishable material, although in our wooded country, often with a lack of sufficient means to construct permanent ones, the engineer may be compelled to construct wooden culverts; in cases of this kind they should be constructed of such size that when renewal becomes necessary, or the means are at hand to construct permanent ones, they may be built inside of the old culverts, and thus avoid a disturbance of the road surface and its consequent expense and annoyance.

Drains of the smaller size should be constructed of iron or vitrified pipe. Many of our pipe manufacturers make a vitrified double strength culvert pipe at a reasonable cost; and these make a most efficient, durable drain when properly constructed; but their exposed ends should be protected by a brick or rubble masonry wall. If of brick, protect the wall with a stone coping.

In crossing water courses it often becomes necessary to construct bridges instead of culverts. The science of bridge building is a specialty, and should be delegated to some person who has made it a special study, in order to secure the best results for the least amount expended.

After properly attending to the matter of drainage, the formation of the road-bed and surface requires our attention, and here the result of all our previous labor of preparation will commend itself. If a common road only is to be constructed,

without any special surface covering, then we refer to our specifications herewith submitted and recommend that, so far as possible, the work be done in accordance with their requirements. If gravel, macadam, or some other form of road covering is to be used, then a road-bed constructed as specified may well serve as a foundation upon which to place the wearing surface.

Without entering too largely into detail as to the various kinds of covering which may be used, we desire to give a few hints as to their construction. If but a narrow roadway, (say eight or ten feet) of plank, gravel, macadam, or some other material is to be used, then place it upon one side of the center of the roadway, and on that side in the direction of which the heaviest traffic passes.

Particular care should be taken in the construction of stone or gravel roads; if upon a clay soil, even though ever so well drained, the stone should never come in contact with the clay, as in the process of time the two become intermingled, the stone seeking an unattainable bottom, and the clay working to the surface; but upon the sub-grade of clay formed, spread a few inches of sand, and upon this deposit the stone.

So many scientific works treating of the construction and maintenance of roads are obtainable, that we refer the inquirer to them for detailed information regarding methods of construction. Among the many publications we call to mind, "Road Making and Maintenance," by Herschel and North; "A Move for Better Roads," being a compilation of prize essays on the subject of road making and maintenance; "Roads, Streets, and Pavements," by Gillmore.

While the matter of maintenance or keeping roads in repair was not specifically referred to your committee, it is so closely connected with the subject directly referred that we cannot omit a few words regarding it. "After a road has been properly constructed, rolled, and the surface made smooth and compact, it should always be maintained in that condition, no matter how great is the amount of travel on it." "A stitch in time saves nine,"—here as well as elsewhere. The tendency is to produce ruts; these hold water, this soaks up the road-bed, and spoils the whole. Without continual repairs there can be

no such thing as a constantly good road,—a proposition that cannot be too often repeated.

"By repairing a road annually or twice a year, it matters not which, the result is, strictly speaking, a good road at no time during the whole year. The road is wretched just after repairs it becomes passable after awhile, and deteriorates from that day forward, until it is again made wretched; and so on, *ad infinitum*, according to the present wasteful and commonly followed system."—*Herschel.*

Constant care and continual watchfulness are absolutely necessary that the best results may be obtained at a minimum cost. As ruts and holes begin to make their appearance, pick up the surface at those points, add a sufficient quantity of the road metal, and roll down solid. Prevent dust and mud from accumulating by a judicious use of the broom.

One great evil to which our roads are subjected, an evil which greatly hastens their destruction, and about which little has been said, is the use of narrow-tired wagons.

What is the use of spending money to create good roads when the public at large is allowed to cut them up day after day with narrow tires—tires one and a half to two inches wide, with say from one to one and a half tons on each wheel? Are we lunatics? Does the willing tax-payer, who wants to see and maintain good roads, ever reflect on the destruction and waste occasioned by these knife-like tires on the country roads and city streets?

We go to work and construct in the cities, at heavy cost, pavements adapted to carry about one ton on each wheel with a tire four to five inches wide, and allow an army of trucking companies and contractors, who are engaged in some special line of work wherein they realize large profits, the indiscriminate use of these streets, with tires ranging from one and a half to three inches wide, loaded with one to one and a half tons on each wheel. What is the result? The over-loaded road-bed is cut up and destroyed by the unthinking multitude, in two to four years, when it should last ten, without repairs. Let there be some common sense State and municipal law regulating the

width of tires and the load they shall carry on the different kinds of roads and streets, and compel their use.

A recent writer, and a good one, on the construction and maintenance of roads, says: "Narrow tires have no use in road work. A single horse cart should have at least five-inch tire. Two-horse dumps, six to eight-inch tire. There is nothing new about broad-tired carts, except that we can build better ones than the world has ever seen. It is narrow tires which are comparatively new, and were ordered by the skinflint calculator, one and three-quarter inch wide, to cut inside his neighbors' two inch ruts."

"When the public gets sick of seeing its roads cut to pieces by heavy freighting on narrow tires, disk-harrow wheels will be driven out of use by a more intelligent and scientific fashion." A broad tire is both economical and best for farm use, and why the people of towns and villages, who are submitting to heavy taxation annually for the betterment of roads and streets, will allow them destroyed almost at once by heavy loads on narrow tires, has amazed and dumbfounded the observer, and caused him to exclaim, "Are we a sane people? and do we manifest and display any sound sense, judgment and economy in the use of the agents created by the people for the public good?" Do we not act more like a selfish and greedy army of devastators and destroyers, than wise, prudent and sagacious men?

We would compel every tramp and vag to "work his passage;" under a proper guard, compel him to break the stone which is to be used in the repairs of our roads, and thus convert a source of expense into one of profit.

Cut and remove all noxious weeds and foul growth of every kind, once in May or early in June, and then again in August before the seeds ripen. Clean out and keep all ditches and drains in good repair, and prosecute any one who willfully or maliciously obstructs or damages them.

And now, having rather crudely touched upon some of the main features of road work, we submit this report with the specifications and form of contract, feeling well repaid if, in any way, existing methods may be improved upon.

We again remind you that in making the specifications, we had in mind the construction of a common road in a clay soil. Where other conditions are met with, the engineer, of course, will act accordingly.

Very respectfully submitted,

JOHN J. GRANVILLE,
WM. B. SEARS,
Committee.

CONTRACTS, SPECIFICATIONS, AND BOND.

For the improvement of_____
from_____to_____
Articles of Agreement, made this_____day of _____
_____18____, by and between _____
contractors of the first part, and_____
of the second part. *Witnesseth*, as follows:—

1st. Said contractors agree with said second party that_____
_____will furnish all the material and perform all the labor necessary to improve_____
from_____to_____
according to the plan, profile, and cross section therefor, on file in the office of the_____
_____and which are made a part of this contract, and the specifications hereto attached.

2d. Said contractor will enter upon such work within ten days of the date of this contract, and shall fully complete the same within_____days from date hereof.

_____will give_____personal undivided attention to the work, and shall not assign or transfer_____interests in this contract, or sublet said work, or any part thereof, without the written consent of said _____
will employ competent, orderly workmen and overseers, and discharge whenever directed by said_____
any and all employés deemed by it to be incompetent or disorderly.

_____shall promptly obey all directions in respect to the work given by said_____
or its engineer.

3d. In case said _____shall deem at any time the performance of the work under this contract by said contractor, improper, dilatory, or imperfect, it shall have the right at its election to suspend work at any time by said contractor; to order the reconstruction of the same or any part thereof by said contractor; to relet the work covered by this contract or any part thereof; or by its employés to take possession of, and complete the same; and all amounts paid by it for the completion of said work shall be charged against the contract; and any amount said work shall cost the said_____ _____in excess of the contract price, said contractor and _____sureties herein, shall pay to said_____on demand, together with all other damages, said _____ _____may have sustained, by reason of the failure of said contractor to properly or promptly perform this contract.

4th. To prevent all disputes, it is hereby agreed that the said _____shall in all cases determine the amount and quality of the several kinds of work and material which are to be paid for under this contract, and the amount of compensation at the rates herein provided for; and shall also determine the value of any extra work or material for which prices have not been named in this contract; and shall also decide every question relating to the execution of this contract, on the part of said contractor, and their estimate and decision shall be final and conclusive.

5th. Said contractor further agrees that_____will save harmless the said second party, from all suits or actions of every description brought against said second party, for, or on account of, any injuries or damages sustained by reason of any act of said contractor, _____servants or agents, in the prosecution of the work herein specified; or by reason of any negligence of said contractor, _____servants or agents, in guarding the same, in the use of improper or defective material therefor, or in the performance of any part of this contract; and _____, hereby further agree that so much of the moneys due to _____ under and by virtue of this agreement, as shall be considered necessary by the said _____, may be retained by the said _____, until all such suits or claims for

damages as aforesaid shall have been settled, and evidence to that effect furnished to the satisfaction of the said_____
_____.

6th. The said first party agrees to receive, and said second party agrees to pay, for all work and material of every description done or furnished under this contract, the following sums:

The sum of $_____ for each acre cleared.

The sum of $_____ for each station of 3,000 square feet grubbed.

The sum of $_____ for each cubic yard of excavation.

The sum of $_____ per M ft. B M for culvert timber in place.

The sum of $_____ per lineal foot for all_____inch pipe drain.

The sum of $_____ per cubic foot for brick outlet to drains.

7th. Payments to be made on the basis of estimates made by the engineer and in the following manner:

(State method of payment).

_____
_____

8th. The said_____shall have the right to retain at all times from the estimates, an amount sufficient to pay and discharge all debts incurred by said contractor, for labor performed thereon in the progress of the work, and at its discretion to pay the same to the parties entitled thereto and charge the same against the contract price.

In witness whereof, the party of the first part_____ hereunto set_____hand, and the said party of the second part has caused these presents to be executed by_____ of the said_____under seal of said_____.

_____(Seal.)
_____(Seal.)

The_____
By_____
_____and _____
_____of said_____
_____.

GENERAL SPECIFICATIONS.

Description of Work.—The work to which these specifications and the attached contract refer, consists of the improvement of_____from____ _____to_____by clearing, grubbing, draining, and grading as hereinafter described.

Clearing.—The entire width of the highway shall be cleared of all trees, brush, and other perishable matter which shall be burned or otherwise disposed of by the contractor. All merchantable timber or material within the limits of this improvement are the property of the _____ _____or owner of adjacent land, and will be removed by said_____ or owner of adjacent land, at such times and in such manner as shall least interfere with the progress of the work.

This work shall be paid for at the price agreed upon per acre.

Grubbing.—In all cuts, and in all embankments of two feet or less, the stumps and roots shall be removed and burned or otherwise disposed of; and in all fills of over two feet or less than five feet, all stumps shall be low chopped or cut close to the ground and burned or otherwise disposed of.

Grubbing will be paid for at the price agreed upon per station of 3,000 square feet.

Draining.—Under this head will be included all surface or other drains, culverts, etc.; and in fact, everything pertaining to the drainage of the road.

The entire length of the improvement shall be ditched on both sides, as shown on plan and profile, and of the dimensions as shown on the cross section.

The bottom of the ditch shall be dressed in a skillful and workmanlike manner to the grade as shown by a blue line on the profile. The contractor will not be permitted to use plow or scraper in forming the bottom and sides of the ditch, but this work must be done with mattock and shovel.

The material taken from the ditches shall be used where required in forming the road-bed.

This work shall be paid for at the price agreed upon per cubic yard of excavation.

Culverts.—Under this head will be included all culverts and covered drains of whatever description required upon the line of the improvement, and will be paid for at the prices agreed upon.

Timber culverts shall be constructed of sound, live, merchantable timber, of the kind required, and in the manner as indicated by the engineer in charge, who will furnish the necessary detailed working plans from time to time as required.

The price paid for timber in culverts, shall be understood to mean the timber in the completed culvert, including all necessary bolts, spikes, labor, etc., at the price agreed upon per M ft. B. M. for culvert timber.

Pipe culverts shall be constructed of the best quality vitrified, double-strength culvert pipe, in the manner and place designated by said engineer. The pipe must be laid to the line and grade as given by the engineer.

Trenches sufficiently deep to receive the bell of the pipe must be made in order that the body of the pipe may rest solidly upon the bottom of the trench.

Should the bottom of the trench, in the opinion of the engineer, be unsuitable to lay the pipe upon, then such method shall be pursued as he may direct, in order to secure a firm foundation for the pipe, and the contractor will be allowed such extra compensation as may be deemed just.

All joints shall be well cemented.

After the pipe is laid, care must be taken in refilling the trench that the pipe is not disturbed. The contractors will be required to supply a sufficient quantity of sand or gravel to fill in at the sides and for six inches over the pipe; this must be carefully tamped. The trench shall then be refilled to the surface with the excavated material.

The price paid for culvert pipe shall be understood to include furnishing and laying the pipe, and making the necessary excavation and back filling.

Outlets.—At the outlet of all pipe drains, a suitable protection wall shall be constructed of hard, well-burned brick or stone, laid up in cement mortar, and constructed in accordance with the plans to be furnished by the engineer.

The price paid per cubic foot for this work will be understood to include to the furnishing of all necessary materials and labor; and in the measurement of such work, openings will be excluded.

Tap Drains.—The contractor will also be required to construct all tap drains which may be deemed necessary by the engineer for the proper drainage of the road, and will be paid for the same at the price agreed upon per cubic yard of excavation, and also such further compensation as may be deemed just, for any extra clearing and grubbing which he may have to do by reason of such tap drain.

Grading.—Under this general head will be included all excavations and embankments required for the formation of the road-bed, or in any way connected with, or incident to, the construction of the same, or in the change or crossing of roads and streams.

All grading shall be done and estimated by the cubic yard, measured in excavation, and paid for as excavation only.

The road-bed shall be graded to conform to the profile and cross section on file in the office of the----------

Excavation.—All cuts shall be made to conform to the grade line as shown on the profile and cross section, and all surplus material from such cuts, shall be hauled by the contractor and used in constructing embankments where required.

Embankments—Shall be made to conform to the profile and cross section, and shall be made with material taken from the ditches, and with the surplus from excavations. No perishable material of any description will be allowed in the embankments.

In constructing embankments of two feet or more, the material shall be deposited in regular layers not exceeding twelve inches, and each layer shall be thoroughly rolled with a horse roller weighing not less than 800 pounds.

In all fills of twelve inches or less, the original surface shall be thoroughly and deeply plowed and well harrowed; sufficient material from the ditches or excavations shall then be added to bring it to the required cross section and grade.

No extra compensation shall be allowed for embankments, but it shall be understood to be included in the price paid for excavation.

Grading.—After the excavations and embankments have been brought to the required grade and cross section, the entire road-bed shall be deeply plowed and well harrowed, and all sods, stones and rubbish removed from the surface. The form of the road-bed shall then again be brought to the required cross section, and the whole repeatedly and thoroughly rolled with a roller weighing not less than five tons.

The entire work shall be done in a thorough and workmanlike manner, strictly in accordance with these specifications and to the satisfaction of the _____ and the engineer in charge.

Know all men by these presents, That _____ as principal and _____ as sureties _____ are held and firmly bound unto the _____ in the sum of _____ dollars lawful money of the United States of America, to be paid to the said _____ its successors or assigns, for which payment, well and truly to be made, we bind ourselves, our heirs, executors, and administrators, jointly and severally, by these presents.

Seals with our seals, dated _____ day of _____ in the year one thousand eight hundred and _____

Whereas, the said _____ entered into a contract with the _____ bearing date the _____ day of _____ eighteen hundred and _____.

Now the condition of this obligation is such, that if the said _____ shall well and truly keep and perform all the terms and conditions of the said contract on _____ part to be kept and performed, and shall indemnify and save harmless from all suits and actions, the _____ has therein stipulated, then this obligation shall be of no effect, otherwise it shall remain in full force and virtue.

_____ (Seal.)
_____ (Seal.)
_____ (Seal.)
_____ (Seal.)

STATE OF MICHIGAN, } ss.
County of ---------- }

On this ---------- day of ----------
18----, before me, a notary public, in and for said county, personally came ---------- one of the sureties named, and who joined in the execution of the aforesaid bond, who makes oath and says that he is worth double the penalty in said bond specified, over and above all debts, liabilities and exemptions, in property situated and subject to levy in the State of Michigan.

Subscribed and sworn to before me this ---------- day of ----------, 18----.

Surety.

Notary Public.

STATE OF MICHIGAN, } ss.
County of ---------- }

On this ---------- day of ----------
18----, before me, a notary public, in and for said county, personally came ---------- one of the sureties named, and who joined in the execution of the aforesaid bond, and who makes oath and says that he is worth double the penalty in said bond specified, over and above all debts, liabilities, and exemptions, in property situated and subject to levy in the State of Michigan.

Subscribed and sworn to before me this ---------- day of ----------, 18----.

Surety.

Notary Public.

The report of the committee was discussed, amended and approved by the society as amended and herewith printed.

QUESTIONS OF PRACTICE.

What is the method by which to apportion the cost of a survey between the different owners on a section? The statute says, "in proportion to the amount of work done for each." How do you get at how much is done for each?—F. L. Church.

Referred to a committee consisting of Messrs. Strong, Rogers and Skeels. Messrs. Strong and Rogers' report is to apportion not altogether by acres but according to benefits and work done. Mr. Skeels says, divide the cost equally among those wanting the work done.

F. HODGMAN: It seems to me the committee have not answered the question. Mr. Church understands what the law requires. The question with him is *how to comply* with it. I have carried out my opinion in my practice for twenty-four years as county surveyor. The apportionment of the tax is a purely arbitrary matter of which the county surveyor is the only authority and the only judge. No general rule can be made. The surveyor must judge of each section and each lot on the section according to its own particular circumstances as to amount of clearing line and difficulty in running it, trouble in finding original corners and other modifying circumstances. Other things being equal, there is but little difference in the amount of work required to survey an eighty or a forty, and either one takes more work than a quarter section on a section which has not had the quarter lines run and the center definitely located.

I always try to eliminate from the tax all charges but my own. Then having apportioned my own charges among the several lots as equitably as possible, if some owners have furnished help on the survey and others have not, I take off from the tax of those who have furnished help and add to that of those who have not. This of course amounts to my paying the help and waiting till taxes are collected for my pay, but I am satisfied to do it, and they do not object. When I do not take this course, I

make account of all the help furnished by the parties to the survey at the ruling wages and apportion the total cost among the several parcels of land and give each man an order on the township treasurer for the amount to be paid him for help he has furnished to be paid out of that tax. I never try to bring the apportionment down to a fine figure, but make it in even dollars and quarters. I always do this at the time of making the survey so that any who wish to can pay their shares at that time. I never have had any grumbling over the apportionment. It is a matter that every county surveyor must settle for himself according to his ideas of right and even-handed justice in carrying out the intent of the law.

DESIGNATING THE CORNERS ON A SECTION.

Mitchell, Antrim County, Mich.

Secretary of Michigan Engineering Society:

DEAR SIR—I send herewith an idea of mine in regard to a method of indicating, in field notes, the corners of a section. If you think it worth while please present it to the Association.

Designate all corners by two figures either of which may be followed by a fraction. The first of the two to denote the line running east and west across the section on which the corner is located and the second the intersecting line running north and south. The corners on the south line of the section to have 1 for the first number, the eighth line next to it to have 2, the quarter line to have 3, the next eighth line 4, and the north section line 5. The second number to commence with 1 for the east section line and all other numbers follow to the west same as the others to the north. The corner on lines dividing fractionally the regular subdivisions of the section to have the number for the line south or east of it followed by a fraction indicating its distance from it. In case of fractional sections 5 should be the number for the section line on the north or west. If the section was large so as to admit of a corner at a mile and another at the section line, the first could be denoted by 5 and the other by (5) or some similar device.

The trouble with giving each corner a letter or number for me is that I cannot remember them. This method saves remembering only the principles.

F. L. CHURCH.

U. S. LAND SURVEY.—NAMING SUBDIVISION CORNERS OF A SECTION.

The statement below will indicate a method of designating these corners. Let the regular U. S. corners be named in the manner prescribed in the instructions to surveyors general for use in the field notes of the original survey. Section 22 is used as an illustration.

1. Cor. 15, 16, 21, 22.
2. ¼ P. 15, 22.
3. N.—N. E. ⅛ St'k, 22.
4. Cor. 14, 15, 22, 23.
5. E.—N. E. ⅛ St'k, 22.
6. ¼ P. 22, 23.
7. Cor. 22, 23, 26, 27.
8. ¼ P. 21, 27.
9. Cor. 21, 22, 27, 28.
10. ¼ P. 21, 22.
11. W.—N. W. ⅛ St'k, 22.
12. E.—N. W. ⅛ St'k, 22 or W.—N. E. ⅛ St'k, 22.
13. Cen. N. E. ¼ 22.
14. S.—N. E. ⅛ St'k, 22 or N.—S. E. ⅛ St'k, 22.

Cen. Sec. 22. J. B. DAVIS.

MR. HODGMAN: The fact that nearly every surveyor uses in his field notes some form of abbreviation to designate the corners on a section is sufficient evidence of its necessity. I have for a great many years used a method of my own and it has been used by others with satisfactory results. I contemplate putting it in the next edition of my Land Surveying as I believe such a publication will do much toward securing uniformity among surveyors. I do not consider my method any better than many another that might be suggested, but it is a method that has worked satisfactorily for a great many years. If the society prefers some other plan and will agree on it I shall be very willing to substitute it for my own in the manual.

MR. ROGERS: I have used the plan suggested by Mr. Hodgman, and have found it satisfactory in every respect.

MR. TEED: The system which I have used for a good many years, I took from a government plat.

(Describes it according to diagram.)

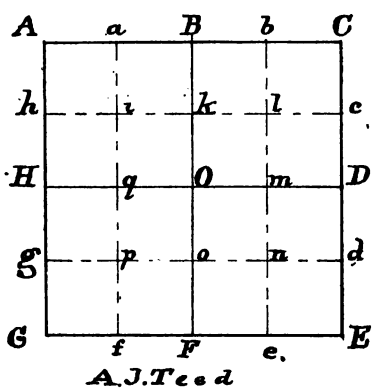
I employ a rubber stamp, in order to obtain uniformity; and prefer letters to figures, because it avoids confusion.

MR. HODGMAN: I suppose it does not make very much difference what plan you use so long as you have a system and understand it, but I do think it would be well to have a uniform system which we could all use.

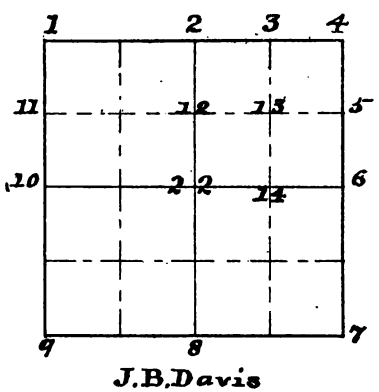
MR. TEED: I cannot change mine, because I have my stamps.

MR. STRONG: I think that the system which the secretary advocates is the best which the society can adopt. I have known of it for some time. There is a great advantage in reading over your record, you don't have to refer to your diagram. It is very simple.

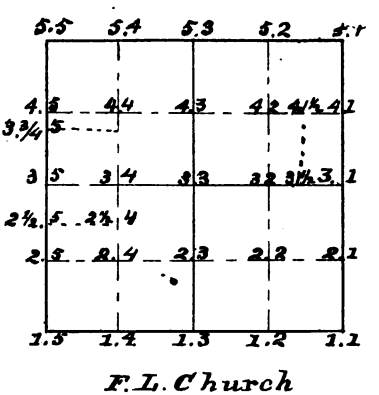
I move that there be a committee appointed to investigate these plans, and report on the one of which they approve, and have it published.



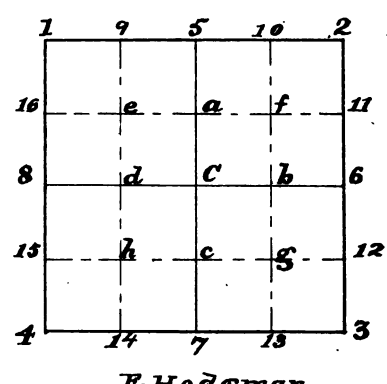
A.J.Teed



J.B.Davis



F.L.Church



F.Hodgman

Motion carried, and Messrs. Strong, Rogers and Skeels appointed such committee.

When the committees report was called for they were not agreed and the following discussion took place.

MR. STRONG: I have drawn on Mr. Hodgman's plan, which is the first that ever came to my attention. It shows for itself on the board. The first four figures, 1, 2, 3 and 4, are used to designate the corners of the section. Each figure or letter always represents the same corner in your own note book, and especially in the record.

5, 6, 7, and 8, are used for the quarter posts, and are referred to in the same way. 9, 10, 11, 12, 13, 14, 15, 16, in smaller type, represent the eighth posts on the section lines. These are referred to in the notes in their proper place in all cases, by these numbers. The interior eighth posts on the quarter lines, are indicated by the small letters of the alphabet, a, b, c, d, on the quarter lines. The next four, e, f, g and h, indicate the centers of the quarters.

After this system has been used some length of time, in reading your record, and looking over record after record, for the eighth post, you need not even glance at your plat. The location is fixed in your mind. A capital C indicates the center of the section.

MR. SKEELS: It is understood, the object was to get some form or plan to put into Mr. Hodgman's Manual. Now so far as I am concerned, it is no matter which one goes in. I preferred this one because it was more simple, less complicated, as I look at it. We have no figures at all. We use the letters, A, B, C, D, E, F, G, H, capital letters, for the government corners, the figure 0, for the center of the section. If we could use the figures 1 to 9, there would be no danger of any difficulty, but when you use 10, 11, 12, 13, 14, 15, 16, you have to use two marks of the pen or pencil for what could be done with one?

MR. STRONG: I presume the sense of the committee would be to refer this whole matter to a committee of the whole.

MR. HODGMAN: The matter was brought up by Mr. Church's letter, suggesting that some plan be adopted to secure uniformity, and that the action of this society in adopt-

ing some plan for conciseness in keeping field notes would be of great benefit to the profession generally. I think it would be well if we could all adopt some plan, and use it. I do not expect surveyors who have plans of their own to change, but those who are about to adopt a plan, could adopt this to secure uniformity.

The plan reported by the chairman of the committee is the one I devised for my own use twenty-six years ago, and have used constantly in my practice ever since. When I refer to a particular corner, I refer to it either by letter or number, and I have arranged them in such an order, that if by chance by being out of practice, and not familiar with it, I can by following the plan in my mind, see in just an instant, where any number or letter should be. I prefer to have the principal points on the section line represented by numbers, and the inside corners by letters. The main thing however, is to have some plan to be agreed upon in the future and used. I never thought that particular plan was any better than other plans, it is consistent, and is a plan.

THE PRESIDENT: It strikes me gentlemen we are hardly prepared to select one, and recommend it as a society. It seems to me it would be the best thing to publish Mr. Church's letter, and represent all three of the plans in the proceedings, and when the secretary calls for ballots for officers, send out a little ballot on the subject and allow each member of the society to vote. We will have a chance then to study the three, and make a choice. At the next meeting, the society will be prepared to make a selection.

PROF. DAVIS: If it is a matter to be put to vote, I will speak of it. I should vote against all three of the plans, and make a combination.

THE PRESIDENT: I suppose that would be all right.

PROF. DAVIS: I should urge taking a different one. The ground I take would be this, briefly.

We already have a system of notes for the subdivision of the township lines, in use, authorized by the land office, and I would respectfully suggest that the plan for us to follow would be the plan given in those notes. Designate all the corners just as they are designated in the United States notes; that

would bring us down to the subdivision of sections. When we come to subdivide sections, I would suggest then, any kind of a system which pleases the writer, which would be intelligible to courts, or people who are not themselves surveyors, and not familiar with any system of abbreviation, and would necessarily have to learn the system of abbreviation in order to interpret these notes.

I have used such a system for a great many years, anybody can read and understand it. If they understand a little about the government subdivisions they can take my notes and read them.

When I mean the center of the northeast quarter, I say so, if I mean the south, southwest 8th post, I say so. I suggest that the system conform to that already in existence, under the ruling of the United States statutes, the usual form of government notes, and whatever is added to them, in a shape so that it will be intelligible to courts and people who have to use these notes.

MR. TEED: The objection I have to Prof. Davis plan, is this: When we are taking our notes in the woods, we are not situated as we would be in an office. It is either raining or snowing, hot, mosquitoes biting, or something happens. Now it seems to me that the system that requires the fewest marks to be made in the book, and those marks, the original notes, that are made right on the ground, is the best system to put in the book. It is difficult, when your fingers are cold, to go and describe anything at length, literally, when a letter or figure covers the whole ground.

I do not always make my calculations exactly right in the woods. I like to have the original data right there so as to correct any possible error in my notes. It is quite an objection to the government method of keeping notes that you cannot do this. It is raining, or something is happening, that you must condense your notes, and yet have them correct.

PROF. DAVIS: I have met that objection steadily for twenty years, and will meet it now, on the old ground, that the surveyor is entitled to time, equipment and outfit adequate to do his work as it ought to be done, to collect his pay for the same; and to spend it as he sees fit.

MR. TEED: Suppose you are four or five miles in the woods and have to catch a train and are not allowed any more time than you have got?

THE PRESIDENT: I understand that Prof, Davis's objection is to abbreviating right along.

MR. HODGMAN: It strikes me that when the average citizen, not a surveyor, hears Prof. Davis speak of the south southwest $\frac{1}{8}$th stake he will know about as much about it as he will when he hears me speak of corner 14. Mr. Church's plan is only adapting to a section the system employed by the government for abridging the notes of a township. It is perfectly simple but because of the number of figures used I prefer either of the plans used by Mr. Teed or myself. I think Prof. Davis' objection does not fairly apply to these plans because I can and do use the United States system of keeping field notes, only using the abbreviations instead of writing out the name of the corner in full. If I am at work on section 27 and begin at the N. W. corner, instead of saying that I began at the corner of sections 21, 22, 27, and 28, I write down that I began at 1 and ran thence on random, etc. So, too, when planting a corner and making witnesses to it, instead of writing the corner down as the southwest corner of the northwest quarter of the northeast quarter of the section or as the east northwest $\frac{1}{8}$ stake, I say, set post at *a* and marked such and such bearing trees. In so doing I secure both brevity and accuracy. I am much less liable to mistake than if I write it out in my notes in full.

PROF. DAVIS: I think that is true. I could have my notes in a more convenient form, still following the plan of the government form, but abbreviating.

THE PRESIDENT: I would suggest that Prof. Davis furnish a sketch like that, and that the whole four be voted upon.

PROF. DAVIS: If you wish.

ABSTRACT OF LEGAL DECISIONS OF INTEREST TO CIVIL ENGINEERS AND SURVEYORS.

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ADVERSE POSSESSION.

1. The law presumes that a grantee in possession claims up to the boundaries of the tract described in his grant—*Lewis v. John L. Roper Lumber Co.* (*N. C.*), *18 S. E., 52.*

2. Where a person obtains and holds possession of land under an agreement with another, who is in possession by the assent of the true owner, and it does not appear what the arrangement was between the owner and the person in possession, the former cannot claim title by adverse possession, since the presumption is that he and the one under whom he claims held as tenants. —*Butler v. Bertrand* (*Mich.*), *56 N. W., 342.*

3. In an action to quiet title, it appeared that plaintiff's land was north, and defendant's land was south, of a half-section line. *Held*, that a finding that defendant had been for five years in possession of the strip in dispute is not sustained by evidence that the strip has been lying open and unoccupied, and that defendant only claimed the land lying south of the half-section line.—*Gordon v. Booker* (*Cal.*), *32 P., 593; Reyburn v. Same, Id., 594.*

4. Adverse possession to give title must be actual, continued, visible, notorious, distinct and hostile.—*Paldi v. Paldi* (*Mich.*), *54 N. W., 903.*

5. Where land has been condemned for a railroad right of way, and the owners of the land adjoining have built on the lines established by the survey, the actual adverse possession of the land up to such lines for more than 15 years, without the claim of a right of easement therein by the railroad company, bars its right to possession of any portion of the land beyond such lines, though there was an error in such survey.—*Louisville & N. R Co. v. Quinn* (*Ky.*), *22 S. W., 221*; *Same v. Wallace, Id.; Same v. Welch, Id.*

6. Rev. St. Art. 3191, provides that every suit for recovery of real estate, as against any person in peaceable and adverse possession under "title, or color of title," shall be instituted within three years after the cause of action accrues. Article 3192 provides that by the term "title," as used in the preceding article, is meant a regular chain of transfer from or under the sovereignty of the soil, and by "color of title" is meant a consecutive claim of transfer down to such person in possession, without being regular, as if one or more of the memorials or monuments be not registered, or not duly registered, or be only in writing, or such like defect as may not extend to or include the want of intrinsic fairness and honesty, or when the party in possession shall hold the same by a certificate of headright, land warrant, or land script, with a "chain of transfer" down to him. *Held*, That in an action to recover possession of real estate, the defense of three years' adverse possession was not available where defendant's title or color of title rested in parol.—*Finch v. Trent* (*Tex. Civ. App.*), *22 S. W., 132.*

7. Possession by a tenant in common and joint tenant is not adverse where no claim is made adverse to the titles of the other tenants, and they are in possession with him; and it is immaterial that, under such circumstances, he pays taxes and makes improvements.—*Pierson v. Conley* (*Mich.*), *55 N. W., 387.*

8. In ejectment, where defendant claimed under a deed from B, and relied on the adverse possession of himself and grantor, there was evidence that in 1861 B employed a farmer to look after the land; that the farmer did substantially nothing more than drive his cattle there at times to pasture, and authorized two men to cut the grass; that the land was used by the neighborhood as a pasture, and that any one who chose cut the grass; that the supervision of the farmer ended in 1876 or 1878; and that the land remained unoccupied until 1882. *Held*, That the evidence of adverse possession was not sufficiently "clear and cogent" to allow the question to go to the jury.—*Judson v. Duffy* (*Mich.*), *55 N. W., 837.*

9. A person claiming land adapted to grazing and growing hay, every year, for a period of more than 10 years, cut the grass and harvested the hay from such portions of the land as

permitted it, using the land in connection with, and in the same manner as he used other tracts claimed by him, and adjacent thereto—there being at different periods fences or plowed strips, not entirely inclosing the whole, but of such a character as to indicate a connection between the tracts—and paid all the taxes, and at intervals warned off trespassers, and distrained cattle grazing thereon. *Held*, That such acts constituted actual, continuous, notorious, and adverse possession.—*Lantry v. Parker* (*Neb.*), *55 N. W., 962.*

10. The possession of one's agent is, for the purpose of the statute of limitations, the possession of the principal.—*Lantry v. Parker* (*Neb.*), *55 N. W., 962.*

11. Actual, notorious, continuous, and exclusive possession of land by an adverse occupant for more than 15 years will give title thereto, though such possession is without color of title.—*Anderson v. Burnham* (*Kan.*), *34 P., 1056.*

12. The possession of land by one who enters under an agreement to buy, but who does not pay the price, is not adverse until he repudiates the vendor's title and asserts his own.—*Spratt v. Livingston* (*Fla.*), *14 So., 160.*

13. Where defendant and his predecesssrs have been in actual possession of land for more than 40 years under deeds duly recorded, the descriptions in the most of which correspond with the lines of occupation, it is immaterial that the descriptions in some of the old deeds are defective.—*Bay v. Posner* (*Md.*), *26 A., 1084.*

14. Possession of land under a deed from one who holds merely a sheriff's certificate of sale does not begin to be adverse till expiration of the period of redemption from the sheriff's sale.—*Morse v. Seibold* (*Ill. Sup.*), *35 N. E., 369.*

15. Possession of land as the result of an entry on the premises by permission of the legal owner will not become adverse until some act is committed by the occupant rendering it so, and notice thereof is brought home to the owner of the legal title.—*Smith v. Hitchcock* (*Neb.*), *56 N. W., 791*; *Same v. Mount, Id., 793.*

16. Where the owner of land occupies it concurrently with one who entered by his permission without color of title, such possession of the owner negatives any presumption that the

other's possession is adverse to him.—*Smith v. Hitchcock, (Neb.), 56 N. W., 791; Same v. Mount, Id., 793.*

17. Possession of land by a railroad company, and its use as a right of way for more than 20 years, constitute good title.—*East St. Louis & C. Ry. Co. v. Nugent (Ill. Sup.), 35 N. E., 464.*

18. A title acquired by adverse possession is one in fee simple, and is as perfect a title as one by deed.—*Dean v. Goddard (Minn.), 56 N.*

19. A person who dedicated land to a city for use as streets had the right to use such land for any purpose consistent with the right of the city, until its authorities determined to open the streets, and the fact that the land remained inclosed and obstructed after the dedication, and was used by such person for pasturage or the growth of crops, did not show adverse possession, as against the city.—*City of Little Rock v. Wright (Ark.), 23 S. W., 876.*

20. Possession of land under the impression that it is a part of the public domain is not adverse.—*Beaumont Lumber Co. v. Ballard (Tex. Civ. App.), 23 S. W., 920.*

21. Whether the possession of a strip of land belonging to the adjoining owner is adverse is dependent on the intention of such possessor, and such intention is a question for a jury.—*Ayers v. Reidel (Wis.), 54 N. W., 588.*

22. The public cannot be ousted by adverse possession of its right to a highway once dedicated.—*Almy v. Church (R. I.), 26 A., 58.*

23. The neglect of city officers to assert the public right during the period of the statute of limitations will not have the effect to transfer to a private claimant any part of the city property held in trust for public use; and the principle is not affected by the fact that the property is intended for a street but has never been graded, or otherwise improved as a street by the city authorities.—*City of St. Louis v. Missouri Pac. Ry. Co. (Mo. Sup.), 21 S. W., 202.*

24. Adverse possession for 10 years, in order to constitute title, need not have been made in good faith, but must have been made under a claim of title.—*Wilkerson v. Eilers (Mo. Sup.), 21 S. W., 514.*

25. The erection of a fence by defendant on plaintiff's lot, under a misapprehension as to the true location of the boundary line, and with no intention to claim any part of plaintiff's lot, cannot serve as a basis of a claim of title by adverse possession as to the portion of plaintiff's lot so fenced in; and an instruction that plaintiff must have known of defendant's claim, and acquiesced in it, before defendant can claim title by adverse possession is harmless error.—*Goldsborough v. Pidduck (Iowa), 54 N. W., 431.*

BOUNDARIES.

1. A conveyance of part of a lot abutting on an alley on the north, by a description which makes the point of beginning the northeast corner of the lot, as shown on the map of the block, and then runs along the north end of the lot a certain distance, carries the fee to the center of the alley, subject to the easement of the other lot owners.—*Hennessy v. Murdock (N. Y. App.), 33 N. E., 330.*

2. The alley having been kept open between two lots which lay next a street, the title to the fee of the alley between such lots is not affected by the fact that the other lot owners along the alley had run a line fence along the center of the alley, so as to include a half thereof within each adjoining lot.—*Hennessy v. Murdock (N. Y. App.), 33 N. E., 330.*

3. In an action involving the location of a boundary line between two city lots, evidence that all the lots in the block are of uniform width, and that the boundary claimed by defendant would render plaintiff's lot six feet narrower than any other lot in the block, sustains a verdict in plaintiff's favor.—*Goldsborough v. Pidduck (Iowa), 54 N. W., 431.*

4. The line between the northeast and northwest quarters of a quarter section is to be extended south from a point midway between the northeast and northwest corners, rather than from a point on such line 1,320 feet from one of the corners.—*Packscher v. Fuller (Wash.), 33 P., 875.*

5. The original government corner had been tampered with and there were three points alleged to be the true corner. There being no one positively to identify the correct corner, *held,* that surveys from known government corners, both north

and south and east and west of the corner in dispute, by which it was located on a line with other corners on both of said lines, and each landowner was given the full amount of land called for by his patent, would be preferred to a survey not begun at a known government corner, lacking many elements of certainty, and giving one owner much more than his patent called for, and the other less.—*Woods v. West* (*Neb.*), *56 N. W.*, *30.*

6. Possession by the grantee under a deed, intending to claim only to the true boundary, is not adverse as to land beyond the boundry occupied by him, and will not ripen into title.—*Silver Creek Cement Corp. v. Union Lime & Cement Co.* (*Ind. Sup.*), *35 N. E.*, *125.*

7. A grantee, who never located and fenced off any definite boundary, cannot claim title by constructive possession as to any land beyond the true boundary called for by his deed.—*Silver Creek Cement Corp. v. Union Lime & Cement Co.* (*Ind. Sup.*), *35 N. E.*, *125.*

8. Where a party to an action to establish a boundary line claimed title to land by adverse possession within his inclosure for over fifteen years, his statements to uninterested persons that he claimed to a certain interior line, and, after a survey, that he intended to move back his fence, do not work an estoppel, but may be introduced in evidence to show an absence of adverse claim of title.—*Critchlow v. Beatty* (*Ky.*), *23 S. W.*, *960.*

9. A boundary line is sufficiently established by evidence that it was plainly marked over 75 years before; that those from whom the parties derived title recognized it as the boundary, and that it was surveyed and recognized by those in possession over 20 years before; though it differs from the original patent in not running to an established point, and is junior in date, and though the surveyor thinks there was a mistake in the survey.—*Critchlow v. Beatty* (*Ky.*), *23 S. W.*, *960.*

10. A deed to plaintiff described the land conveyed as beginning at the northwest corner thereof, "at the junction of" F. avenue and the B. road; thence south, "by" F. avenue; thence east to the land of defendant, etc. The lands of plaintiff and

defendant were parts of the same tract, and conveyed to them by the same grantor. If plaintiff's west line was in the middle of F. avenue, the description would include the quantity of the land intended to be conveyed, with the dividing line where defendant claimed it to be; but, if plaintiff's west line was along the east side of F. avenue, the description would not contain the quantity intended to be conveyed, without encroaching on defendant's land. *Held*, That plaintiff's west line was the middle line of F. avenue.—*Cochran v. Smith* (*Sup.*), *26 N. Y. S., 103.*

11. The rule that monuments control courses and distances applies to discrepancies in government surveys between the courses and distances and the witness trees called for in the field notes.—*England v. Vandermark* (*Ill. Sup.*), *35 N. E., 465.*

12. While the corners of a survey as actually established and marked on the ground by the United States government surveyors control the designation of such corners in the plats or field notes, yet the presumption is that the corners have been established at the places indicated by such field notes; and the proof that the actual establishment was different must be clear and convincing, where the actual location as claimed does not accord with the section lines in adjoining sections, and will establish the claim in an irregular shape.—*Cadeau v. Elliott* (*Wash.*), *34 P., 916.*

13. In order to locate an intermediate post in a survey of land, which was run also by courses and distances, the footsteps of the surveyor should be followed, instead of taking a reverse course.—*Blackburn v. Nelson* (*Cal.*), *34 P., 775.*

14. Where, to settle a dispute as to a boundary between adjoining land owners, the county surveyor establishes a line upon an actual survey, one of such owners who participates in making and paying the expenses of the survey, acquiesces in it for a considerable time thereafter, is bound thereby, and it will not be disturbed because a new survey, made some years later, shows a mistake in the establishment of such line.—*Benson v. Daly* (*Neb.*), *56 N. W., 788.*

15. Incidental calls, noted in field notes as such in passing, unless specially designated in such manner as to show an

intention to make them locative, will not ordinarily have precedence over calls for courses and distances.—*Hanson v. Township of Red Rock, in Minnehaha County (S. D.), 57 N. W., 11.*

16. Though known and fixed monuments control where they conflict with the courses and distances, yet where there are two conflicting monuments, one of which corresponds with the courses and distances, that one should be taken, and the other rejected as surplusage.—*Zeibold v. Foster (Mo. Sup.), 24 S. W., 155.*

17. A boundary line fixed by a surveyor employed by various property owners is not binding on such owners as against an adjoining owner, who was not a party to the surveying, and who never acquiesced in the line as fixed by the surveyor.—*Kampmann v. Heintz (Tex. Civ. App.), 24 S. W., 329.*

18. Of two overlapping surveys, the one first made has priority, particularly where the second is bounded with express reference to the first.—*Van Amburgh v. Hitt (Mo. Sup.), 22 S. W., 636.*

19. Any calls of the second survey conflicting with monuments and calls of the first must yield thereto.—*Van Amburgh v. Hitt (Mo. Sup.), 22 S. W., 636.*

20. When the field notes returned by a government surveyor show that section and quarter section corners were established on a straight line between township corners, and fix their location by courses and distances, they will be accepted as presumptively correct, and can be overcome only by the most clear and satisfactory evidence.—*Hanson v. Township of Red Rock in Minnehaha County (S. D.), 57 N. W., 11.*

21. When old mounds, with pits and stakes having the appearance of government mounds, are found at points distant from the points indicated by the government field notes, by courses and distances, they afford but slight evidence that they are the original government mounds, unless they have existed for a long time, and have been generally recognized as the undisputed government corners.—*Hanson v. Township of Red Rock, in Minnehaha County (S. D.), 57 N. W., 11.*

22. Calls in a deed, fixing the boundaries of the estate conveyed by land of adjoining owners, will prevail over other calls describing the estate by distances.—*Smith v. Catlin Land & Imp. Co. (Mo. Sup.), 22 S. W., 1083.*

Where the issue is whether the line separating plaintiff's land from defendant's is unknown, and a permanent boundary has been agreed upon by their grantors, and possession has been taken and held accordingly, defendant cannot complain of an instruction that, before a finding for him on such issue, the jury must be satisfied that there was a mutual agreement between the owners to that effect, though the fact that one of the owners built a fence, and cultivated the land up to it, will not of itself be sufficient to prove such agreement, but it is proper to take into consideration the long acquiescence of the adjoining owners to such line of division.—*Coleman v. Drane* (*Mo. Sup.*), *22 S. W., 801.*

23. In ascertaining the true line of a city street, fences built by adjoining lot owners on the line of the street, according to stakes set by the surveyor soon after the original survey was made, and maintained for 45 years, are better evidence of the location of such line than a new survey, made 40 years after the original survey, which changes such line.—*City of Racine v. Emerson* (*Wis.*), *55 N. W., 177.*

24. In proceedings to establish boundaries, evidence of corners recognized and acquiesced in by the adjoining owners for over 10 years was competent.—*Williams v. Tschantz* (*Iowa*), *55 N. W., 202.*

25. On appeal from the commissioner's report in proceedings to settle disputed boundaries and lost corners, under Acts 15th Gen. Assem. c. 8, the appellee may, at the close of appellant's evidence in chief, file a reply to appellant's exceptions to the report, alleging that the line established by the commissioner, though different from the government line, is nevertheless the true line, because maintained and acquiesced in by appellant and those interested for more than 10 years. Given, J., dissenting.—*Williams v. Tschantz* (*Iowa*), *55 N. W., 202.*

26. Where the field notes of a survey are inconsistent, the true description of the survey may be shown by the evidence of the surveyor who made it.—*Schley v. Blum* (*Tex. Civ. App.*), *22 S. W., 264.*

27. Where there is a discrepancy, in a government survey, between the monuments and the distances given in the field notes, the monuments will control, even though the result be that some of the quarter sections will contain less than their

proper number of acres.—*Ogilvie v. Copeland* (*Ill. Sup.*), *33 N. E., 1085.*

28. Disputed boundaries between adjoining lands may be settled by express oral agreement, executed immediately, and accompanied by possession according to such agreement.—*Teass v. City of St. Albans* (*W. Va.*), *17 S. E., 400.*

29. In an action to quiet title, it appeared that plaintiff's land was north, and defendant's land was south of a half-section line, the location of which depended on the location of the half-section corner on the east line of the section. The surveyor who ran the half-section line found a stake on the east line of the section, which he assumed to be the half-section corner. Three surveyors and two other persons, testified that the stake found was the government corner. There was no evidence that a corner had been found at a different place in that vicinity. Measurements from a known corner, 1½ miles south of the half-section line, would place the corner 24 feet north of the stake found, but a line due west from such point would locate the west half-section corner 20 feet north of its known location. *Held*, That the court erred in holding the half-section corner to be 24 feet north of the stake found, since evidence based on courses and distances from other known points is inadmissible to change the location of an original corner, when found.—*Gordon v. Booker* (*Cal.*), *32 P., 593; Reyburn v. Same, Id., 594.*

30. In trespass to try title, it appeared that J., under whom both parties claimed, conveyed the north 50 feet of a lot to plaintiff, the balance going by mesne conveyances to defendants. At the time of the purchase by plaintiff, J. pointed out a fence as his north line, and a line 50 feet south, marked by stakes as his south line. Plaintiff adopted both lines as true, and they were true according to the distances mentioned in the deed to J., but according to the courses of said deed both lines were 30 feet too far north. *Held*, That plaintiff is confined to the 50 feet of land lying between the fence and stakes, since the courses in a deed must yield to distances when such was the evident intention of the parties.—*Scott v. Weisburg* (*Tex. Civ. App.*), *21 S. W., 769.*

31. The true corner of a governmental subdivision of land is where the United States surveyors in fact established it.—*Beardsley v. Crane* (*Minn.*), *54 N. W., 740.*

32. Where, owing to meandered lakes, but one quarter corner post was established upon the ground on the boundary lines of a certain section, which post was on the south line thereof, the division line between the southeast and the southwest quarters of said section must be ascertained by running a line due north from the quarter post to the meandered lake upon the north side of the section.—*Beardsley v. Crane* (*Minn.*), *54 N. W., 740.*

33. Where the boundary of land is described in a deed as running on the bank of a certain brook, and such brook has both a main and an auxiliary channel, "brook" means the main channel, in the absence of evidence that the parties did not use the word according to its ordinary signification when referring to one of the two branches of the stream.—*Pike v. Hood* (*N. H.*), *27 A., 139*; *Hood v. Pike, Id.*

34. A grant "to the seashore, thence by the seashore," does not carry title beyond highwater mark.—*Brown v. Heard, 27 A., 182, 85 Me., 294.*

35. Where adjoining landowners agree on a disputed division line, and such line is acted on and acquiesced in by them it is binding on them and those claiming under them without regard to the length of time it was so acted on and acquiesced in.—*Bailey v. Baker* (*Tex. Civ. App.*), *23 S. W., 454.*

36. On a resurvey of land originally belonging to the United States, which it had surveyed, such resurvey must follow the boundaries and monuments, as run and made by the government survey, if the monuments placed to indicate the section corners, and quarter section posts can be found, or the places where they were originally placed can be identified.—*Randall v. Burk Tp., of Minnehaha County* (*S. D.*), *57 N. W., 4.*

37. Where adjoining owners, by a private survey, have fixed on the wrong one of two blazed lines as their boundary, there being no question as to the real line, there is no such "practical location" as will fix the line by possession in less than twenty years.—*Buchanan v. Ashdown* (*Sup.*), *24 N. Y. S., 1122.*

38. Mere acquiescence in the private survey of a doubtful boundary line where no improvements have been made on the land except clearing timber, works no estoppel.—*Buchanan v. Ashdown (Sup.), 24 N. Y. S., 1122.*

39. In case of occupancy by mistake beyond a line capable of being ascertained, the intention to claim title to the extent of the occupancy must appear to be absolute, and not conditional; otherwise the possession will not be deemed adverse. Emery J., dissenting.—*Preble v. Maine Cent. R. Co., 27 A., 149, 85 Me., 260.*

40. One who by mistake occupies land not covered by his deed, with no intention to claim title beyond his true boundary, wherever that may be, does not acquire title by adverse possession to land beyond the true line. Emery J., dissenting.—*Preble v. Maine Cent. R. Co., 27 A., 149, 85 Me., 260.*

41. Where the description of land in a deed calls for a legal subdivision of a section of surveyed land the quarter section corners being lost, and the section exceeding 640 acres in area, the division lines of the fractions of the section are determined by a division pro rata of the lines of the section as they appear upon the ground.—*Eshleman v. Malter (Cal.), 35 P., 860.*

42. W. street lies along the north shore of the Ohio river with a defined width, but no lots were ever laid out between the street and the river. The land between the street and river is uninclosed, but has been regularly sold by the original owners and their grantees. *Held*, That an owner of a lot abutting on the north side of the street owns the fee to the middle of the street only, and has no riparian rights along the river bank.—*Haslett v. New Albany, Belt & Terminal R. Co. (Ind. App.), 34 N. E., 845.*

43. Plaintiff claimed under a deed bounding him by the seashore and a road, and asserted the road to be a boundary, as if constructed in a right line with its general course until it should reach the shore, whereas, in fact, in its building, the road had been deflected northerly, and a few rods short of the seashore. *Held*, That the road as actually built was the monument, and constituted plaintiff's boundary.—*Brown v. Heard, 27 A., 182, 85 Me., 294.*

44. In an action to recover possession of land it appeared that plaintiffs owned land bounded by the meander line of a

lake as first surveyed by the government in 1855; that the waters of the lake receded, and left the land in dispute lying between the present and original meander line of the lake; and that defendant took possession of and built a house on the land in 1879, and has ever since resided there. Defendant claimed and witnesses testified, that the land first settled on by him was an island, separated from plaintiff's land by water several feet deep, and was part of the public domain. Several witnesses supported plaintiff's claim that no such island ever existed, and the plat of the original survey of the township showed none. *Held*, That the evidence was sufficient to justify a verdict for defendant as to the facts in issue.—*Moore v. Brownfield (Wash.), 34 P., 199.*

45. Where, in a controversy as to the division line of real estate, it appears that there is no record of the original monuments or surveys, so that recent surveys are only approximately correct, the testimony of those who remember where the corners and line were, as shown by a fence erected nearly 40 years before the trial, and subsequently removed on becoming dilapidated, will control, in favor of the party claiming to such line and occupying the premises for many more than 20 years prior to the bringing of the action, as against the paper title of the parties, and the evidence of many witnesses that they do not remember such fence, and that they had never seen it.—*Richwine v. Presbyterian Church of Noblesville (Ind. Sup.), 34 N. E., 737.*

DEDICATION.

1. When the owner of land divides it into numbered lots on certain streets, represented on a plan of the land, made at the time, and conveys lots, by number, bounded by such streets, referring to the plan as a part of the description, the land so designated as streets becomes dedicated as such, and such dedication is binding on the proprietor and his grantees, though the plan were not recorded; and a grantee cannot claim damages for land taken for streets delineated on said plan, though these had not been opened at that point when the grantee received his deed.—*Danforth v. City of Bangor, 27 A., 268, 85 Me., 423.*

2. Where property in a city is deeded as a "block" in a certain "survey," and is described as bounded by streets, and the recognized maps of the city show streets and avenues around the block, other evidence of a dedication of the streets is not necessary, in an action between property owners and the city, involving the boundary line of the street.—*Witherspoon v. City of Meridian, 13 So., 843, 69 Miss., 288.*

3. Though the owner of land in a village has it surveyed, and staked off into lots and streets, and makes a map of the same by which lots are sold from time to time, during a period of 10 years, bounded by the streets as shown by such map, such acts are not so unmistakable in their purpose, and decisive in their character as to constitute a dedication of the streets indicated on such map to the public use.—*People v. Kellogg (Sup.), 22 N. Y. S., 490.*

4. The death of the owner is a revocation of a proffered dedication of streets, and an acceptance thereafter by the village gives it no right in the streets.—*People v. Kellogg (Sup.), 22 N. Y. S., 490.*

5. Where a person made and executed a plat of land by his duly authorized attorney in fact, and after the recording thereof sales were made of lots therein described and houses built on them, streets opened, and highway labor performed on them, such acts constituted a dedication and acceptance thereof by the public of such streets, and it was immaterial that such person did not himself sign and acknowledge the certificate attached to the plat.—*Ruddiman v. Taylor (Mich.), 55 N. W., 376.*

6. Where village trustees put up at the street corners the name of a street shown by a map under which lots have been sold, put water and light on the street as far as houses are built, and make a map for a system of sewers, which shows the street as one of the village highways, it is sufficient to show an acceptance of the street.—*People v. Underhill (Sup.), 23 N. Y. S., 388.*

7. Where the owners of land plat it as an addition to a town, so as to show what appears to be the prolongation of its streets (though not so designated) and for eight years acquiesce in the grading and public use of such apparent streets, the erection

of sidewalks, and the construction of costly improvements upon adjacent private property, and represent to a person who, on the faith thereof, purchases a portion of the addition adjoining the apparent street, that such portion will abut upon the same as streets, they are estopped to deny the existence of the streets. —*Likes v. Stone* (*Neb.*), *55 N. W., 878.*

8. Where a person owns land in fee, or the common source of title from whom all parties interested claim, and has it surveyed into lots, blocks, and streets, and a map of it, which he recognizes as being correct, is made with a view of establishing a town, and he sells lots with reference to the map, designating the parcels sold and the streets according to the map, there is an irrevocable dedication of the streets to the public, whether the town at that time was incorporated or not.—*Ham v. Common Council of Dadeville* (*Ala.*), *14 So., 9.*

9. Though the partition deeds of land which was platted in anticipation of the extension of a city to such land, expressly provided that a street named in the deeds should not be considered as dedicated to the city or to the public, a dedication of such street could be implied from the use of the street by the partitioners and their vendees, the extension of the street after the city had extended beyond the land, the construction by the city of an expensive bridge where the street crossed a stream, the improvement of the street by the city more than 20 years after the partition, and the failure of the partitioners or their vendees to institute legal proceedings to restrain the construction of the bridge and improvements as trespasses, and their availing themselves of the benefits of the improvements. —*Caperton v. Humpick* (*Ky.*), *23 S. W., 875.*

10. A bill by a railroad company to enjoin a city from opening a street across its right of way without compensation showed that it had entered on the right of way, and constructed its road, under an agreement that the right of way should be conveyed to it in consideration of its constructing its road; that subsequently, in pursuance thereof, a conveyance was made to it of the right of way over certain lands in defendant city "as now surveyed, laid off, and drawn;" that in the meantime the owner of the land had filed a plat of the land, showing streets and the line of complainant's right of way, pursuant to Act

Feb. 28, 1837 (Acts 1886-87, p. 93), providing that the recording of such a plat shall be a conveyance in fee of the portions thereon marked or noted as donated to the public, and that the portions shown thereon as intended for streets and other public uses shall be held in trust for the purposes intended or set forth. *Held*, That the bill showed that the fee of the streets was conveyed to the public, subject only to complainant's right of way, and that the conveyance to complainant was in accordance therewith.—*Birmingham Mineral R. Co. v. City of Bessemer (Ala.), 13 So., 487.*

DEED.

1. A deed, which conveys "78 rods off the south side of the northwest quarter" of a section describes a certain fractional part of the quarter, 78 rods wide, on the south side, extending along the entire length.—*Cobb v. Taylor (Ind. Sup.), 33 N. E., 615.*

2. Where the description in a deed is such that a surveyor can locate the same, it is sufficient.—*Campbell v. Carruth (Fla.), 13 So., 432.*

3. Where the other terms of the description contained in a deed are not sufficiently certain, the number of acres given is an essential part of the description, and may be resorted to in aid of the defective part of such description.—*Campbell v. Carruth (Fla.), 13 So., 432.*

4. Where a deed described the land as being "known on the map of the United States survey as the northwest quarter of the northwest section 8, township 29 south, of range 16 east, containing 40 acres," it was a sufficiently certain description of "the northwest quarter of the northwest quarter of" said section 8, in said township and range; and the omitted words, "quarter of," next preceding the word "section," in the description, would be supplied by construction as a palpable omission.—*Campbell v. Carruth (Fla.), 13 So., 432.*

5. Where a call in a deed was for "a survey in the name of Meader," and in subsequent deeds for "a survey in the name of Meadows," the bad orthography in the name, with no other facts, could not produce uncertainty in the description of the

land, the other calls being correct and proper.—*Sloan v. Thompson* (*Tex. Civ. App.*), *23 S. W., 613.*

6. A deed of a portion of a platted lot, describing the granted premises as extending west 72 feet from the northeast corner of the lot, fixes the beginning point, not at the center of the street on which the lot abuts, but at that portion of the platted territory set apart for individual and separate use, though the plat, in giving the size of the lots, measures to the center of the street.—*Montgomery v. Hinds* (*Ind. Sup.*), *33 N. E., 1100.*

7. Where a grantor conveys a wharf property by clear and definite description, and adds to the description the following words, "Also one-half of an acre of land near the wharf or at the wharf," the deed will be regarded as effective to convey a particular half acre near the wharf which the parties, either before or after the execution of the deed, marked out or identified and appropriated as the parcel intended to be conveyed.—*Simpson v. Blaisdell, 27 A., 101; 85 Me., 199.*

8. A clause in a deed, at the end of a particular description of the premises by metes and bounds, "meaning and intending to convey the same premises conveyed to me," is merely a help to trace the title, and does not enlarge the grant.—*Brown v. Heard, 27 A., 182; 85 Me., 294.*

9. Though a deed fails to recite in what state the lands, described by section, town, and range, are situated, and though the grantor's acknowledgment is taken in a foreign state, yet where a certificate of the official character of the notary is appended to the acknowledgment, and the deed is recorded in a county within the state where the lands are in fact located, the land is sufficiently identified.—*Mee v. Benedict* (*Mich.*), *57 N. W., 175.*

10. A definite description in a deed, naming the point of beginning, the monuments, and courses and distances, followed by a statement as to the number of acres conveyed, passes only the quantity of land included in the specified boundaries, though that is less than the number of acres stated.—*Silver Creek Cement Corp. v. Union Lime & Cement Co.* (*Ind. Sup.*), *35 N. E., 125.*

11. A lot was described in a deed merely by number, without mention of a strip adjacent thereto and to other adjoining

lots. In platting the land the grantor had left the strip as if for a passage, though it was not so called on the plat. *Held*, That the grantee had no exclusive right to the strip lying adjacent to his lot, but was bound to allow its use equally by adjoining owners.—*O'Brien v. Flynn* (*Mass.*), *33 N. E., 500.*

12. Where a deed to a railroad company describes the land conveyed by reference to the line of the road of such company as then located, but not built, the boundary lines are not affected by a subsequent change in the location of the road.—*King v. Norfolk & W. R. Co.* (*Va.*), *17 S. E., 868.*

13. Where an agreement has established a disputed boundary a subsequent conveyance by the privies to the parties to the agreement, by the same description as that under which the title was acquired and possession held prior to the agreement, will pass the title according to the agreed boundary.—*Smith v. Catlin Land & Imp. C.* (*Mo. Sup.*), *22 S. W., 1083.*

14. Plaintiff received a deed for property described as beginning on O street, 30 feet west of a certain alley, and running west on that street 52½ feet. He subsequently conveyed to defendant's predecessor in title a portion of said land, describing it as beginning 50 feet east of S street, and running east on O street 25 feet; "being the western 25 feet of property acquired by" plaintiff as above. The distance between the alley and S street was 135 feet. *Held*, That the call in the deed to defendant of 50 feet east of S street as the point of beginning was evidently false, and must be rejected, the remainder of the description being sufficient to identify the property.—*West v. Bretell* (*Mo. Sup.*), *22 S. W., 705.*

15. A deed which describes the boundaries of the land as beginning "at a point on the east side" of a road, and thence running north a certain number of feet, continuing the line to the place of beginning, does not convey the fee of the road.—*Blackman v. Riley* (*N. Y. App.*), *34 N. E., 214.*

16. A conveyance of land bounded by a road should be construed as referring to the actual road as worked and used, and not to an abstract legal line, invisible and practically unknown. —*Blackman v. Riley* (*N. Y. App.*), *34 N. E., 214.*

DRAINAGE.

1. Elliott, Supp. § 1186, provides that, where a petition is filed with the drainage commissioners for drainage improvements, they shall consider the practicability, the benefits to be derived, and the cost and, if they approve the petition, they shall estimate the cost, and report to the court under oath. *Held*, that, where the commissioners made a negative report it was not necessary for them to verify it.—*Blemel v. Shattuck* (*Ind. Sup.*), *33 N. E., 277*.

2. It is not necessary that the commissioners' report, under Elliott, Supp. § 1186, should contain a statement of the estimated cost of the work, and the benefits or injuries to each tract.—*Blemel v. Shattuck*, (*Ind. Sup.*), *33 N. E., 277*.

3. Where the grounds of a motion to set aside the report of drainage commissioners appointed pursuant to Act April 6, 1885, are based on matters outside the record, and are not supported by affidavit or other proof of their truth, such motion is properly overruled.—*Blemel v. Shattuck* (*Ind. Sup.*), *33 N. E., 277*.

4. The right of way of a railroad company cannot be sold to pay the lien of a drainage assessment, but a personal judgment for such assessment may be rendered against the company. Ross J., dissenting on the ground that special assessments are strictly in rem. *Louisville, etc., Ry. Co. v. State, 24 N. E., 350, 122 Ind. 443*, followed.—*Louisville, N. A. & C. Ry. Co. v. State* (*Ind. App.*), *35 N. E., 916*.

5. Laws 1885, Act No. 277, c. 3, § 1, provides that no drainage commissioner shall take action towards establishing a drain until there is filed with him an application signed by not less than five freeholders of the township; that the petitioners shall be jointly and severally liable for the costs if the commissioners decide that the same is not necessary, or if the proceedings be dismissed for other cause; that the commissioner may recover such expenses by suit at law if petitioners refuse to pay. *Held*, that where a petition was filed for the extension of a drain, and the proceedings were dismissed on the ground that the proposed drainage was unnecessary, the persons who filed such petition cannot, in order to defeat an action against them

for costs, claim that it was impossible to determine the necessity of such drain because the line was not sufficiently described in the petition; it not being permissible for them to take advantage of defects in their own petition.—*Rosenstiel v. Miller* (*Mich.*), *55 N. W.*, *655*.

6. Where there is no record of the laying out of any drain in a certain township, on which land is assessed in a certain year, and the tax list does not show for what drain the tax is assessed a sale of such land for delinquent drain tax of such year, and the tax deed issued in pursuance thereof, are void, when, also, the sale and deed were made by the county treasurer, instead of the auditor general.—*Loose v. Navarre* (*Mich.*), *55 N. W.*, *435*.

7. Under 3 How. St. § 1740f4, providing that no drain tax shall be spread on the assessment rolls unless directed by the board of supervisors, as in cases of other township taxes, a supervisor is not authorized to spread such tax in the absence of an express direction so to do; and it is not sufficient that the board adopted the report of the special committee appointed to recapitulate the reports of the several township clerks to the county clerks for all moneys voted to be raised by townships, in which report the amount to be raised for drains was included.—*Post v. Harris* (*Mich.*), *54 N. W.*, *898*.

HIGHWAYS.

1. Under Act March 31, 1876, § 52, declaring that roads used as public roads for the five years preceding the passage of the act are highways, the public user is the only thing to be considered, without regard to the owner's intention in permitting it.—*Freshour v. Hihn* (*Cal.*), *34 P.*, *87*.

2. A town may change the grade of a highway within its limits so that the surface water falling on such highway is diverted from its usual course without incurring liability to the owner of adjacent land on which such surface water flows when so diverted.—*Champion v. Town of Crandon* (*Wis.*), *54 N. W.*, *775*.

3. A highway, as originally described in the return of the commissioners in 1871, was to run along the shore of a lake, six rods from high water mark. The high water mark was never

established, and the highway, as at present claimed, crosses complainant's land 157 feet from the water's edge. In platting two villages, about half a mile apart, near both of which the alleged highway was, the highway was practically ignored, and in the street as now claimed there was a swamp hole, and the public traveled wherever the best opportunity offered. *Held*, that a highway by user was not established.—*Schroeder v. Village of Onekama* (*Mich.*), *54 N. W., 642.*

4. Rev. St. 1881, § 5104, provides that the board of turnpike directors may enter on any lands in the county and take gravel for the repair of the free gravel roads, and shall give a certificate to the owner of the land, stating the value thereof, together with the amount of damages to the land by the removal of the gravel; and, if the owner is not satisfied with the value so certified by the board, he may appeal to the circuit court. *Held*, that it is not necessary that a landowner file with the board any claim for the gravel.—*Bell v. Pavey* (*Ind. App.*), *33 N. E., 1011.*

5. On trial in the circuit court of an appeal from the board of turnpike directors on the award to a landowner for the removal of gravel, pursuant to Rev. St. 1881, § 5104, all pleadings and papers in the transcript on appeal are a part of the record, and may be considered by the jury without being formally introduced in evidence.—*Bell v. Pavey* (*Ind. App.*), *33 N. E., 1011.*

6. How. St. § 1315, provides that all roads which have been laid out, and not recorded, and which have been used eight years, or more, shall be deemed public highways, subject to be discontinued by certain proceedings for that purpose. *Held*, That where a road has been laid out by a township, and actually used for eight years, it became a public highway, and the mere nonuser for a period of two years, in the absence of any proceedings to discontinue it, did not entitle a railroad company crossing the road to exclude the public by fencing in its right of way.—*McNamara v. Minneapolis, St. P. & S. Ste. M. Ry. Co.* (*Mich.*), *55 N. W., 440.*

7. Where a road is openly used as a highway by the public, and is recognized by a railway company as such, by permitting the public to cross the track, and by assuming to maintain a crossing at that point, it is immaterial that the road has not

been legally established. Kelly v. Railway Co., 9 N. W., 588, 28 Minn., 98, followed.—*Lillstrom v. Northern Pac. R. Co. (Minn.), 55 N. W., 624.*

8. A public highway, legally established, ordered to be opened, and one-half of which at least was unobstructed, and used to some extent for public travel, is not "unopened," within the meaning of Gen. St. 1889, par. 5516, vacating all country roads which may have remained "unopened" for seven years. —*Webb v. Board of Com'rs of Butler County (Kan.), 34 P., 973.*

9. Defendant, for the purpose of changing the course of a highway, opened a road through his land, fenced it on both sides, allowed it to be used by the public, and to be worked and controlled by the public authorities. *Held*, That the road was dedicated to the public.—*McKenzie v. Gilmore (Cal.), 33 P., 262.*

10. Where streets are opened, and traveled by the public, and the city claims control over them, and defendant does not allege or attempt to show any right to obstruct them, evidence of a formal acceptance of the streets by the city is unnecessary. —*City of Scranton v. Scranton Steel Co. (Pa. Sup.), 26 A., 1.*

11. In an action to recover a forfeiture for an encroachment on a town road it appeared that the road was laid out on a certain section line, and not from any natural or fixed monuments. The state produced evidence of the location of an original quarter post, and thus claimed to locate the section line. Defendant introduced surveys to show that the line was located elsewhere. *Held*, That it was proper to charge that, if the jury found that the original quarter post was located, that would control, but, if not, then they were to determine where the correct line was.—*State v. Wertzel (Wis.), 54 N. W., 579.*

MUNICIPAL CORPORATIONS.

1. A city, in grading a street, encountered a steep ravine, across which it raised an embankment on the line of the street, (24 to 36 feet high and 140 to 60 wide). In this ravine much surface water was collected and carried off during each year. In the plans and specifications for the street adopted, in order to provide drainage, a culvert or sluiceway was constructed in

the channel of the ravine, under the embankment, 2 by 3 feet in size. The embankment was built of earth taken from cuttings just as it came, and was more or less pervious to water. The sluiceway was allowed to fill up, so that there was more or less water standing above the embankment all the year, and in July, 1892, it was 10 or 12 feet deep. The city had long known of the filling of the sluiceway, and now made some ineffective efforts to clear it. The embankment was already visibly sapped. A heavy storm on July 26 filled the space above the embankment nearly to the top, and August 3 it broke, and property owners below were severely damaged by the water. *Held*, That the city was negligent in failing to keep open the sluiceway.—*Stoehr v. City of St. Paul* (*Minn.*), *56 N. W., 250.*

2. Saginaw city charter, tit. 6, § 7, authorizes the common council, after the completion of the improvement, to issue a resolution reciting the improvement, the cost, the apportionment thereof among the parties interested, and the amount to be assessed on the lands benefited.—*Auditor General v. Maier* (*Mich.*), *54 N. W., 640.*

3. Where it appears from the record that the lands alone were assessed for the benefits received, and that no personal assessments were made, the fact that some of those whose names appear on the roll as owners were not in fact owners is immaterial.—*Auditor General v. Maier* (*Mich.*), *54 N. W., 640.*

4. Where in an action to collect a special city assessment, it appeared that defendant's lands consisted of two contiguous lots, which should have been assessed separately, but were not, and no objection thereto was made in his answer, defendant is precluded from raising the point on appeal.—*Auditor General v. Maier* (*Mich.*), *54 N. W., 640.*

5. Pub. Acts 1889, No. 195, known as the "General Tax Law," provides (section 96) that the act shall be applicable to all cities, where not inconsistent with their respective charters. Saginaw city charter, tit. 6, § 26, provides that special taxes shall become a lien on the premises, as other city taxes; payment thereof shall be enforced in the same manner as annual taxes, and for non-payment thereof the premises shall be sold in the same manner as for the non-payment of other city taxes. *Held*, That both the charter and the general tax law contemplate

and provide for the collection of taxes, special as well as general, by suit in the circuit court, at the instance of the State.—*Auditor General v. Maier (Mich.), 54 N. W., 640.*

6. Saginaw city charter, tit. 5, § 10, requiring that the provisions of the law respecting the return and sale of property for the nonpayment of taxes for state, county and township purposes shall apply to the return and sale of property for the nonpayment of city taxes, authorizes the return of lands delinquent for nonpayment of all city taxes.—*Auditor General v. Maier (Mich.), 54 N. W., 640.*

7. A district sewer 10,500 feet long was built by a contractor in full compliance with the plans of the city engineer, and under his immediate supervision, and was duly accepted by the city. *Held,* That the fact that 195 feet of the sewer ran through private property, the owners of which had not consented thereto, did not relieve the property owners from paying for that part of the sewer that ran through the public streets.—*Johnson v. Duer (Mo. Sup.), 21 S. W., 800.*

8. After a contract and bond for the construction of a sewer have been approved and confirmed by an ordinance, and the work has been done thereunder, it is too late to object that the contract was not let to the lowest bidder, where the ordinance under which the contract was entered into authorizes the engineer to "reject any and all bids if deemed too high, or the parties bidding are deemed irresponsible."—*Johnson v. Duer (Mo. Sup.), 21 S. W., 800.*

9. The fact that part of the land in a sewer district cannot be drained by the sewer is no objection to the validity of the special assessment to pay for such sewer, where the only parties objecting are those whose lands are drained by the sewer.—*Johnson v. Duer (Mo. Sup.), 21 S. W., 800.*

10. An assessment to pay for the cost of a sewer may be levied on the lands benefited according to their area without regard to their value.—*Johnson v. Duer (Mo. Sup.), 21 S. W., 800.*

11. Where, in an action for damages against a railroad for the destruction of plaintiff's crops by overflow of water, from the defective construction of defendant's roadbed, in not having sufficient culverts to carry off the water, it appeared that plaint-

iff was only the lessee of the land, defendant's contention on appeal that plaintiff was guilty of such contributory negligence as to defeat his right of recovery in that he did not dig a ditch to carry off the water, and thus prevent the distruction of his crops, as he might have done; will not be sustained.—*Galveston H. & S. A. Ry. Co. v. Borsky* (*Tex. Civ. App.*), *21 S. W., 1011*; *Same v. Ryan, Id., 1013.*

12. Though it is "the duty of a party to protect himself from the injurious consequences of the wrongful act of another, if he can do so by ordinary effort and care, or at moderate expenses," such rule has no application in an action for damages against a railroad for the destruction of plaintiff's crops by overflow, from the defective construction of defendant's roadbed, where the injury could only have been prevented by the digging of a ditch at a cost of $300; the digging of a ditch at such cost not being "ordinary effort and cost" or a "moderate expense."—*Galveston, H. & S. A. Ry. Co. v. Borsky* (*Tex. Civ. App.*), *21 S. W., 1011*; *Same v. Ryan, Id., 1013.*

13. Where a borough in the construction of its gutters, causes the surface water which did not flow in that direction, to be gathered in a body, and flow over a lot abutting on a street, it is liable for the damages thus resulting to the lot owner.—*Bohan v. Borough of Avoka* (*Pa. Sup.*), *26 A., 604.*

14. Where a city collects water through various ditches, and empties it into a city ditch in excess of its capacity, so as to overflow private property, it is liable for the damage caused, even though it was not bound in the first instance to construct or maintain such ditch.—*City of Houston v. Bryan* (*Tex. Civ. App.*), *22 S. W., 231.*

15. The city charter of Detroit provides that before proceeding with any proposed public improvement the common council shall refer the matter to the board of public works, which board shall report thereon to the council, "giving detailed estimates of the costs of such work or improvements;" and the city ordinances provide that the owner of land to be assessed is entitled to notice of the intended improvement, and an opportunity to show cause why the assessment should not be levied. *Held*, That where the council makes a contract for a sewer without any estimate of the cost before it, and no notice of the

improvement was served as the ordinance directs, and it does not appear that the notice was published as directed by the ordinance, the proceedings were void, and the collection of a tax levied to pay for the sewer was properly enjoined.—*Mills v. City of Detroit* (*Mich.*), *54 N. W.*, *897*.

16. A special assessment for a local improvement is void where a portion of the property benefited is arbitrarily and intentionally omitted from the assessment, and that too, though the property assessed is benefited the amount it is assessed.—*Masters v. City of Portland* (*Or.*), *33 P.*, *540*.

17. Act March 18, 1885, p. 147, § 11, provides for an appeal to the city council from an act or determination of the superintendent of streets as to the legality of any assessment; that on such appeal the city council may "confirm, amend, set aside, alter, modify, or correct" the assessment, as it may deem just; that all decisions of the council shall be conclusive, on all persons entitled to such an appeal, as to all errors and irregularities which the council might have remedied. *Held*, That an appeal on the ground that an assessment for paving a cul-de-sac failed to assess the land at the end of the same presented a question which the city council had power to determine, and therefore their decision was conclusive.—*Dowling v. Altschul* (*Cal.*), *33 P.*, *495*.

18. A city in grading an avenue, built an embankment across a creek, and constructed a culvert through it for the passage of the stream. A land company also placed an embankment on its land adjacent to the avenue, through which it constructed a drain of the same dimensions as the culvert built by the city. The drain became obstructed, so that it dammed up the water of the creek, flooded plaintiff's property, and caused damage. *Held*, That the fact that the city permitted the land company to join its drain to that constructed by the city does not render the city liable to plaintiff.—*City of Kansas City v. Brady* (*Kan.*), *34 P.*, *884*.

19. Where the commissioner of public works, with power to discharge assistant engineers, notifies one that he was supended, thereby intending to discharge him, and the engineer, without objection or protest, accepts other employment from the commissioner, it is a question for the jury whether the notice of

suspension was not understood to be a discharge, or, if not, whether the acceptance of the other employment was not an abandonment of the position of engineer. 19 N. Y. S. 6, reversed.—*Wardlaw v. City of New York* (*N. Y. App.*), *33 N. E., 140.*

RIPARIAN RIGHTS.

1. In an action of ejectment it appeared that the plaintiff was the owner of an island in the Missouri river; that defendant was the owner of the land opposite the island on the north; that at the original survey of both tracts in 1817 the main channel of the river ran between the island and defendant's land; that in 1844 the river changed its course, and ran to the south of the island; that the space between the island and defendant's land filled up, thus forming the land the title to which was at issue. *Held*, That it was proper to refuse an instruction requested by defendant that if, after the original survey, a portion of defendant's land was washed away, and afterwards the land was reformed within the limits of such survey, then all the land so formed became the land of defendant, even though it should consist of accretions to plaintiff's land, as such accretions belonged to plaintiff if they began upon his land.—*Naylor v. Cox* (*Mo. Sup.*), *21 S. W., 589.*

2. Where a city lot is separated from the river by a street, owned in fee by the public, the accretion belongs to the street for public use, and not to the lot owner.—*City of St. Louis v. Missouri Pac. Ry. Co.* (*Mo. Sup.*), *21 S. W., 202.*

3. The right of the owner of land, whether rural or urban, on a river shore to the increase thereof, caused by alluvial deposit, is settled in Missouri.—*City of St. Louis v. Missouri Pac. Ry. Co.* (*Mo. Sup.*), *21 S. W., 202.*

4. The rule to determine the division line between adjoining holdings in the shallow waters of a navigable bay, of owners of land bordering thereon, and located on a cove, is (1) to measure the whole extent of the shore line, and compute how many rods, yards, or feet each riparian proprietor owns thereon; (2) to divide the navigable water line into as many equal parts as such shore line contains rods, yards, or feet, and then appropriate to each proprietor as many of such parts of such navigable water

line as he owns rods, yards, or feet of the shore line; and (3) to draw a line from the point of division on the shore line to the point thus determined as the point of division on the navigable water line. Orton, J., dissenting.—*Northern Pine Land Co. v. Bigelow* (*Wis.*), *54 N. W., 496.*

5. Where the navigable water line and the shore line are elongated by deep indentations and sharp projections, the meander line, as located by the government survey, and the actual navigable water line, should be discarded, and the general available shore line and the general trend of the navigable water line adopted. Orton, J., dissenting.—*Northern Pine Land Co. v. Bigelow* (*Wis.*), *54 N. W., 496.*

6. An unauthorized agreement by the lessees of one riparian owner with the adjoiniug riparian owner as to the division line between the holdings in the shallow waters of a navigable bay is void.—*Northern Pine Land Co. v. Bigelow* (*Wis.*), *54 N. W., 496.*

7. Accretions caused by the filling of the shallow waters of a navigable bay or river belong to the riparian owner.—*Saunders v. New York Cent. & H. R. R. Co.* (*Sup.*), *23 N. Y. S., 927.*

8. Where a railroad is constructed across a navigable bay, and the bay is filled from the shore to such railroad, partly by the riparian owners, and partly by the railroad company, so as to exclude the waters therefrom, a grant from the state to such company of the land which originally formed the bed of the bay, for right of way purposes, is unavailing, as against the right thereto of such riparian owners.—*Saunders v. New York Cent. & H. R. R. Co.* (*Sup.*), *23 N. Y. S., 927.*

9. The owner of land fronting on the bay of Duluth platted it into blocks and streets, extending the plat a distance of several blocks beyond the actual shore line, out into the shallow water, but not out to the point of navigability. He then conveyed, according to the plat, the original shore block to defendants, and all the water blocks in front of it to plaintiff. *Held*, That defendants acquired no appurtenant riparian rights in the unplatted space between the outermost platted blocks and the point of navigability, but that such rights passed to defendants.—*Gilbert v. Emerson* (*Minn.*), *56 N. W., 818.*

10. On an issue as to whether the addition to land on the north side of a river was the result of alluvion or avulsion, it appeared that such river was subject to annual rises in the spring and summer of each year. The bank on the south side of the river was higher than on the north side, and during each rise the bank on the south side would cave in, and wash away, and the channel move towards the south side after each rise. Land would form on the north side after each rise. Some years the changes resulting from the rise of the river were greater than during other years, and occasionally the change made by the force of the current could be noticed while it was going on. *Held*, That the increase was caused by alluvion, and was not the result of sudden changes.—*Denny v. Cotton* (*Tex. Civ. App.*), *22 S. W., 122; Same v. Lee, Id.*

11. The fact that such river was, by virtue of treaties between the United States and Mexico, regarded as a navigable stream, does not affect the application of the general law of accretion and alluvion to a determination of the ownership of such land, since the principles of accretion and alluvion apply to navigable as well as nonnavigable streams. *State of Nebraska v. State of Iowa, 12 S. Ct., 397* followed.—*Denny v. Cotton* (*Tex. Civ. App.*), *22 S. W., 122; Same v. Lee, Id.*

12. A contention that plaintiffs were not entitled to the made land, even though it were alluvion, and that their boundary should stop at a stake in the bank of the river as it existed when the original survey was made, is untenable, where such survey called for the river and its meanders as a boundary.—*Denny v. Cotton* (*Tex. Civ. App.*), *22 S. W., 122*; *Same v. Lee, Id.*

13. While the banks are a part of the river, the river does not include lands beyond the banks, which are covered in times of freshet or extreme floods, or swamps or low grounds which are liable to overflow, but are reclaimable for meadows or agriculture, or which, being too low for reclamation, though not always covered with water, may be used for cattle to range upon, as natural or uninclosed pasture.—*Paine Lumber Co. v. United States* (*C. C.*), *55 F., 854.*

14. The bank of a river is that elevation of land which confines the waters of the river in their natural channel when they

rise to their highest, but do not overflow the banks.—*Paine Lumber Co. v. United States* (*C. C.*), *55 F., 854.*

15. The bed of a river is a definite, and commonly a permanent channel, and is the characteristic which distinguishes the water of the river from mere surface drainage, and from water percolating through the strata of the earth.—*Paine Lumber Co. v. United States* (*C. C.*), *55 F., 854.*

16. Low water mark is the point to which the river recedes at its lowest stage. High water mark is the line which the river impresses upon the soil by covering it for sufficient periods to deprive it of vegetation, and to destroy its value for agriculture.—*Paine Lumber Co. v. United States* (*C. C.*), *55 F., 854.*

17. A grant from the United States of land on a large river like the Missouri, navigable in fact, though not subject to the ebb and flow of the tide, will, even when containing no reservation or condition, pass to the grantee title only to the water's edge, but will vest in the state title to the land beneath the water, though the state has adopted the common law.—*Cooley v. Golden* (*Mo. Sup.*), *23 S. W., 100.*

18. The state holds title to the land under navigable waters as trustee for the public, and has no power to grant to a railroad company a strip of land adjoining the shore of a river, so as to cut off a riparian owner's right of access to the waters thereof, 23 N. Y. S. 927, affirmed.—*Saunders v. New York Cent. & H. R. R. Co.* (*Sup.*), *24 N. Y. S., 659.*

19 Rev. St. §§ 454, 455 ("Riparian Act of 1856"), giving riparian proprietors on navigable streams the title to submerged lands above the edge of the channel, and giving them the right to erect wharves and warehouses thereon, and to fill up such lands, does not give them the right to take phosphates from the beds of navigable streams, bays of the sea, or harbors, below high water mark, and out to the edge of the channel, for the purposes of sale.—*State v. Black River Phosphate Co.* (*Fla.*), *13 So., 640.*

20. The owner of land which is described in a patent from the government as bounded on the meander line of any inland lake, though navigable, except the great lakes, is entitled to the accretion lying between the meander line and the edge of the waters.—*Poynter v. Chipman* (*Utah*), *32 P., 690.*

21. The owner of land abutting on the Missouri river holds only to the water's edge, and he acquires no title to the river bed where the course of the river is changed by avulsion.—*Rees v. McDaniel* (*Mo. Sup.*), *21 S. W., 913.*

22. Whether the title of a proprietor of land on the margin of a navigable river extends to high water mark, low water mark, or the middle of the stream, is not a federal question, though he claim under a grant from the United States, but is to be determined by the laws of the state in which the land is situated.—*Webb v. City of Demopolis* (*Ala.*), *13 So., 289.*

23. In Alabama, the title of an owner of land bordering on a navigable stream extends to low water mark, ending only where the right to the use of the water as a navigable stream begins. —*Webb v. City of Demopolis* (*Ala.*), *13 So., 289.*

24. A patent of the United States, conveying land lying upon the borders of a navigable river within the boundaries of a state, conveys no title to the land lying under the stream, since the United States has no title thereto.—*Scranton v. Wheeler* (*C. C. A.*), *57 F. 803.*

25. Where the law of the state, as an incident to the ownership of riparian lands, attaches thereto the legal title to submerged lands, to the thread of the stream, as in Michigan, such title will accrue to one who receives from the United States a patent to the riparian lands.—*Scranton v. Wheeler* (*C. C. A.*), *57 F., 803.*

26. Where an island formed by a freshet in a river does not consist of part of original surveys left intact by the change in the channel, but was formed of deposits within the lines of such surveys, the island is the property of the state, under Civil Code, § 1016, which provides that islands and accumulations of land, formed in the beds of navigable streams, belong to the state, if there is no title or prescription to the contrary.—*Heckman v. Swett* (*Cal.*), *33 P., 1099.*

27. Where ledges or spits or tongues of land project out beyond the meander line of a bay, they are included as part of the fractions of sections shown on the government survey, and conveyed by government patent.—*Ex parte Davidson*, (*C. C.*), *57 F., 883.*

MICHIGAN ENGINEERING SOCIETY.

BUSINESS TRANSACTIONS FOR 1894.

The annual convention was held in the council rooms at Jackson, January 2 and 3, 1894. At the business meeting January 3d, the following reports were made and business transacted:

The following reports were read and approved and ordered to be printed in the annual:

SECRETARY'S REPORT OF DIRECTORS MEETING.

The annual meeting of the board of directors was duly called and held at the Hudson House in Lansing, on Wednesday, October 11, 1893. There were present Director Skeels, Secretary Hodgman and E. O. Sellers, member. In the absence of a quorum of the board, the meeting was adjourned until Friday p. m., October 20, at the Stowell House, Jackson, Mich.

At the adjourned meeting there were present Directors Skeels, Appleton and Davis and Members Granville, Dennis, Fargo. The ballots for officers were canvassed and the following found and declared elected for the ensuing year.

President—E. W. Muenscher, of Manistee.

Vice President—Geo. S. Pierson, of Kalamazoo.

Secretary and Treasurer—F. Hodgman, of Climax.

Directors—J. J. Granville, of Saginaw; Dorr Skeels, of Grand Rapids; J. B. Davis, of Ann Arbor.

The secretary's report was read and accepted and placed on file.

The treasurers report was read and approved and placed on file.

An invitation was received from the mayor and common council of the city of Jackson to hold the next meeting of the society in Jackson, and placing the council rooms at the disposal of the society for that purpose. The invitation was accepted and the date of the convention fixed for January 2, 3 and 4, 1894.

Mr. Granville filed his acceptance of the office of director.

Applications for withdrawal were received from Geo. E. Roehm and W. F. Durand and the applications granted.

Applications for membership were received from Geo. A. Goodenough, C. E. Bement, H. K. Vedder, Henry Melcher and John M. Lally. The first three applications were approved for senior memberships, that of Mr. Melcher for junior membership and that of John M. Lally was laid over until next meeting for further information. The secretary was directed to issue a supplemental ballot for these members, previous to the convention. The memberships of R. J. Coryell, P. B. Woodworth, Geo. A. Mark, D. E. Guiley, J. Luger, A. V. Culebroeck, Geo. Cox and F. S. Kedzie were annulled for non-payment of dues. In the case of John J. Watkins now four years in arrears caused by age and straitened financial circumstances, it was voted that his dues be remitted and that he be transferred to the list of honorary members and the secretary was instructed to convey to him an expression of the good will and high regard in which he is held by the society because of his high personal character and the great amount of good work he has done for the society. Similar action relative to dues and membership was taken in the case of C. B. Hyde because of his old age, ill health and straitened circumstances.

The secretary reported names of those who have promised to furnish papers for the next convention and was directed to request a number of others named to prepare papers.

The members living in Jackson were appointed a local committee of arrangements. The further matter of preparing for the convention was placed in charge of the president and secretary.

Accounts of John J. Granville, $5.00 and Dorr Skeels, $9.00 for expenses of meeting with board of directors were audited and allowed.

The board then adjourned.

J. B. DAVIS, *Chairman.*
F. HODGMAN, *Secretary.*

SECRETARY'S ANNUAL REPORT.

I would respectfully report the following business transacted by me for the society since the last annual meeting:

Immediately after the close of that meeting arrangements were made for the annual convention which was held in January in Lansing and of which a full report is published in the annual for 1893. As soon as possible after the convention the matter was prepared for the annual and the job of printing 1,500 copies thereof and 500 copies of a reprint of 1880 and 1881 reports was let to the Kalamazoo Publishing Company who were the lowest bidders for the two jobs. It took much time and correspondence on the part of the secretary to get enough advertising patronage to be safe in placing the work in the printer's hands. According to contract the annual should have been out May 1, but it was not out till July 25. The main cause of delay was in getting proofs of papers read and returned by the authors. One instance of this kind stopped work on the annual for three weeks. It is a question whether it is just to advertising patrons to permit such delays in getting their advertisements before the readers of the annual. The only way to avoid it is to not send proofs to the authors. That would not be very satisfactory unless the papers are carefully type written, as often the author is the only one who can tell what the correct reading is. Another delay of over two weeks after the last form was set up and everything else printed, was caused by Ihling Bros. & Everard of Kalamazoo, who had contracted for a half page ad. They were notified in the contract that copy must be furnished by April 15, but it was not done and I directed our printers to call on them for the copy whenever they were ready for it. This they did at least three times without success, and at last tired of waiting ran off the last form without it.

When I learned this I had them print and insert a slip. After it was all done the firm sent over their copy and have since refused to pay for their ad. because their copy was not used.

There is a growing demand for our annual reports, the sales the past year being greater than for a number of years previous. We have only about 20 copies each of the reports of 1883, 1886–7, 1888, 1889 and 1890, and I have refused to sell copies of these years except in full sets. I purchased 25 copies of the 1883 reports of Prof. Greene in order to fill out these sets. I would favor purchasing all of the reports of that year that Prof. Greene has on hand. If the demand for them increases it will be necessary in order to supply it to reprint the reports for five years, of which we are short. Another plan which I have long had in view would be to assort the papers on kindred subjects and publish them in book form and put them on the market. I believe they can be made a source of revenue if properly handled. To this end I had our reports copyrighted for the society so that we could control the matter contained in them.

EXCHANGES

have been arranged with similar societies in Connecticut, Canada, Ohio, Indiana, Illinois, Iowa and at the universities at Ann Arbor and Champaign. Others might perhaps have been arranged if we had published a larger edition. Only four of the nine exchanges have yet been received by me. When all are received they will be sent together to the members. Sending in separate parcels as received would involve much extra expense to the members and labor to the secretary.

COLLECTION OF DUES.

Repeated statements of dues have been sent to every member in arrears but there still remains a considerable number who have not paid up. Of those who are two years or more behind and whose membership should be therefore annulled, Mr. R. J. Coryell and Mr. P. B. Woodworth have refused to pay because they have not received the reports. Why they have not is *because* they have not paid their dues. This has

been fully explained to them but they still seem to expect the secretary to violate the by-laws and the express instructions of the society for their benefit. The other members who are two or more years in arrears are J. J. Watkins, four years; G. A. Mark, four years; C. B. Hyde, four years; D. E. Guiley, two years; J. Luger, two years; A. V. Culebroeck, two years; Geo. Cox, two years and F. S. Kedzie two years. Mr. Watkins has expressed a desire to be retained in membership and says he will pay up some time.

APPLICATIONS FOR WITHDRAWAL

have been received from Prof. W. F. Durand and Geo. E. Roehm. Their dues are paid in full and they are entitled to have their applications granted.

APPLICATIONS FOR MEMBERSHIP

have since the last meeting of the board, been received from G. A. Goodenough, C. E. Bement, Henry Melcher and John M. Lally. They are herewith submitted. I would suggest that the board order a supplementary ballot to act on the applications.

CONVENTION.

I have received from the recorder of the city of Jackson an invitation from the common council of that city, to hold our next convention in that place, and tendering us the use of the council rooms, also an invitation from our members in that city. We have been invited there several times but have never met there.

F. HODGMAN,
Secretary.

TREASURER'S REPORT.

I would respectfully report the following sums received and paid out by me for the year ending October 10, 1893.

RECEIPTS.

On hand October 12, 1892	$129 12
Received from members for annual dues	237 40
Received from membership fees	60 95
Received from advertisers	261 30
Received from annuals sold	37 85
	$726 62

EXPENDITURES.

Expenses of board of directors	$24 52
Paid stenographer	61 80
Paid for express, freight and drayage	16 20
Paid for portrait of Forster	31 00
Paid for printing circulars, ballots and blanks	32 91
Paid for postage and envelopes	37 70
Paid for traveling expenses of secretary on society business	26 87
Paid for binding annuals and exchange reports	10 80
Paid Prof. Greene for 1883 reports	5 00
Paid for cuts for the annual	6 05
Paid for telegraphing Ohio and Iowa societies	1 11
Paid for printing annuals	300 00
Paid for American Digest	5 00
Paid secretary salary, 1892	100 00
Balance on hand	67 66
	$726 62

The printers' bill for publishing the annual for 1893 including cuts and express charges paid by them was for 1,500 copies	$338 25
For 500 copies reprint of 1880 and 1881 reports	45 70
	$383 95

The society owes them $83.95 which is the only debt it has.

There is due the society from advertisers including Ihling Bros. & Everard account	$127 00
From sales of reports	13 00
From members, 1893 dues	40 00
	$180 00

This statement omits dues from members two years or more in arrears and also advertising accounts against the Cleveland Frog Co., $10, and Hetterchied Manufacturing Co., $6, which are doubtful of collection.

The financial standing of the society may be summed up as follows:

Assets. Cash on hand	$ 67 66
Outstanding accounts	180 00
	$247 66
Indebtedness to Kalamazoo Publishing Co.	83 95
Net assets	$163 71

I do solemnly swear that the foregoing is a true account of all moneys received and paid out by me for the Michigan Engineering Society for the financial year ending October 10, 1893.

F. HODGMAN,
Treasurer.

Subscribed and sworn to before me a notary public for Kalamazoo county, this 10th day of October, 1893.

W. C. POND,
Notary Public.

SUPPLEMENTARY REPORT TO THE JACKSON CONVENTION.

Since the meeting of the board of directors the secretary has done all that he was able, to prepare for a successful convention, but at the time of the present writing must own to a very decided feeling of discouragement. A majority of those who were requested to furnish papers have not even replied to the request. Some have sent papers but will not be able to be present. Others who promised papers have not been able to fulfill. Some members can always be depended on to do whatever lies in their power for the benefit of the society, and as was shown by President Muenscher, this comparatively small number has so far done all the work. It seems to the Secretary that this state of things is not only most unjust to these working members who have given freely of the fruits of their life-work and experience and got nothing from the others in return, but that it endangers the very existence of the society. It does not seem to him either fair or wise to continue this dependence on the same small circle of members year after year for papers. It does seem that henceforth those who have heretofore done nothing should contribute the greater part of the papers.

The society now has a standing and position of which we have reason to be proud. We want to keep it up with and as near the head of the procession as possible. If the present secretary is for any reason the cause or the occasion of the apparent unwillingness of so large a number of members to do anything for the society he wants to step down and out forthwith, and have a more acceptable man take his place.

He is sorry to say that not all the exchanges are yet received, but the lacking numbers are published and may be expected soon. Since the report to the directors a portion of the outstanding accounts for advertising and dues has been collected and the indebtedness of the society has been paid up in full, so that it is not now in debt for anything except a small bill of printing, for which the bill has not yet been received, amounting perhaps to $5. There is in the treasury cash on hand $30.40. There is due from members for 1893 dues $22, from advertisers $67.

F. HODGMAN,
Secretary.

Mr. Hodgman, Mr. Appleton and Mr. Sears were appointed a committee on resolutions.

Mr. Bailey and Mr. Appleton were appointed a committee on exhibits.

The following persons were placed in nomination for officers for the ensuing year.

For President—Geo. L. Wells, Geo. S. Pierson.

For Vice President—J. J. Granville, A. J. Teed.

For Secretary and Treasurer—F. Hodgman.

For Directors—J. B. Davis and C. E. Greene, of Ann Arbor, Dorr Skeels of Grand Rapids, Miner C. Taft of Kalamazoo, F. F. Rogers of Port Huron, Wm. B. Sears of Saginaw, and Wm. Appleton of Lansing.

MR. HODGMAN: I want to suggest that it is very desirable to have at least one director at Lansing, because the directors meeting is held there, and we have found difficulty in securing a quorum. I think that it might possibly be a good plan to change the time of the meeting of our board of directors. I for one feel decidedly anxious to have at least one member of the board from the University of Michigan. I believe it is a most desirable thing. The time at which we hold our annual meetings of the board of directors, renders it exceedingly difficult for the members from the university to attend. The only way to remedy this is to change the articles of association; it cannot be done at this meeting.

MR. APPLETON: It probably is not possible for us to select our board of directors just as we would like. It is quite desirable to have one member from the University of Michigan, and keep him, not perhaps the same one always, but the University of Michigan should be represented at all times on that board. They do not get the big head and they attend the meetings, and it must be from good feeling, for they are not making much out of it. Now about there being a member from Lansing. That is quite desirable. I am afraid in stating that, I may have a wrong motive imputed to me. Now I am there, and I have been on that board so long gentlemen, that I would be very glad to see almost anyone else take my place, but it is not possible when you get there, to delegate those powers to anyone else. In order to have a quorum, it involves some expense.

MR. WELLS: In the report of the secretary it appears that we have a good field for the use of more money. Now I think by united effort on the part of the members, especially the members who are in construction work, where materials are bought, you can get advertising patronage for the asking; now if forty members get three or four pages, it would give us money enough not only to pay our secretary, more nearly what his services are worth, but allow us to have some of these books reprinted that are needed, and possibly print some papers in a volume; if there was united action on the part of forty or fifty members, it would not be hard work to raise $1,000 a year.

MR. ROGERS: I think our friend Wells has struck the right chord. I thought I would try last year, and I went to a couple of people and asked them to favor our paper, and both responded. I did not know of anyone else, and did not ask them, but Mr. Lucus for one responded to my request, and while I am on my feet, I will say that there is one good feature about his tapes, they are well tempered. I have found them very satisfactory. I have three in use at the present time.

MR. HODGMAN: The financial standing of this society depends very largely upon the advertising matter we obtain. The dues are so low, that they will not any more than pay for the reports themselves, our last report alone, cost more than last year's dues. But by securing advertising, we can meet

these expenses. Heretofore, a few members of the society have aided me materially in securing advertising. If it had not been for that few, we could not have gotten through. But if every member would take hold and assist, it would leave our finances in better condition, and enable us to accomplish things that ought to be done. I think many of us are so situated and so related in the purchases of city supplies, that they might very easily secure advertisements when I could not touch the advertiser.

MR. WELLS: When I was over at the fair, I was thinking about this matter, and seeing a large display of roadmaking machinery and matters of that kind, and the work our society put on the subject of roads last year, I thought if any of our members are interested in good roads, there is a good field for advertising. I am sorry my work does not bring me where I can get hold of these fellows, but there is a chance for someone interested in those things to raise quite a revenue.

THE PRESIDENT: It will be proper at this time to pass upon the question of the compensation of our secretary.

MR. SELLERS: I make a motion that our secretary be allowed $100, and if at the end of the year, something extra can be given from advertising, that it be offered him.

Motion supported and carried.

PROF. DAVIS: There is a matter in the secretary's report that I wish to submit. It is in the form of a question. Would it be asking too much of those who prepare papers, to request them to present them in type written copies to Mr. Hodgman. Would it be advisable to make it a requirement?

THE PRESIDENT: The difficulty is, that it is so much trouble to get them to prepare papers, that if you add any restrictions it increases the difficulty.

PROF. DAVIS: I suspect a great many of these men are like myself, they are averse to showing the secretary their hand writing and it would give them no excuse.

MR. STRONG: I am afraid this may be hedged about with difficulties; as you remarked a few moments ago, papers are not any too freely poured in any way, and while it is perfectly easy for some people to get a type-written copy, it is not for others, but it always is possible to give a plain copy. I hope you will not require that, you might request, but not require.

MR. HODGMAN: In the circular I sent out, I asked authors to prepare the papers so carefully that it would not be necessary to have the proof sent them to read. I don't know how closely they followed the request, but I trust sufficiently well, so that when they see the papers in print they will not feel hurt about it.

PROF. GREENE: I think anyone who writes a paper is entitled to receive the proof for correction. I should prefer not to have mine go into print without seeing it.

THE PRESIDENT: I think that too. One paper of mine was so mixed that it made no sense at all. If the articles could be type-written there would be less to correct.

MR. BEAN: Prof. Greene's remark is to the point. With a lot of mathematical formulæ, it is easy to get the signs changed, so that there will be a very different formula from what was intended. I think it should be sent back to the party who wrote the paper, to examine it.

MR. HODGMAN: Of course if a man gets up here and lectures, there is no sort of question in my mind but that he should have a copy, and an opportunity to revise it. But where a person sits down and prepares a paper, I think it might be prepared so carefully that it need not be sent back, and I have requested this. I mean, that the author should place the ideas and words as he wants them, and have it so plainly written that persons need not mistake the reading.

It is a fact that comparatively few of us write so perfectly that people are not liable to make mistakes in reading it. What I would like, is to have the articles prepared so plainly and carefully that there will be no difficulty in reading it, and when the proof reader compares it with the original, he will have no question as to whether the printed copy is the same thing as was written.

In connection with this, is a question as to whether it is fair to our advertisers, as for instance, people interested in road machines, whether it is fair to keep our Annual dragging along, until the season for their work is past. Many of these advertisements are in regard to articles that should be used in their season; if we wait until the season is over, are we not doing an injustice? Should we not get our Annual out in time? I sup-

posed we could get our Annual out last year, by the first of May; as it was, it was the last of May.

THE PRESIDENT: It seems to me there ought not to be any delay, after the writer receives the proof sheets. A few minutes work will correct the proofs and put them in the post office.

MR. HODGMAN: The trouble is when a man is not at home. Suppose when the proof is prepared and sent to him, he is out of town; it is sent after him, and the paper follows him around for three weeks as a paper did, in one instance last year, while everything else was kept waiting for it, that is the trouble.

MR. ROGERS: I move that those who prepare papers be requested to, so far as possible, send type-written copies to the secretary.

Motion supported and carried.

THE SECRETARY: I would like to bring up the question here, which has been suggested to the board of directors, but no action taken, as to purchasing from Prof. Greene, those reports he has.

Motion made and supported that the secretary be authorized to purchase the copies of the reports for 1883, in the possession of Prof. Greene.

MR. WELLS: There is a matter of which the Secretary spoke last night, and which I think perhaps ought to be brought before the meeting. Mr. Watkins' case. The remission of his dues, and placing him on the roll as an honorary member.

MR. APPLETON: The board of directors did that.

PROF. DAVIS: I don't know whether we have the authority to do that.

MR. HODGMAN: Perhaps that ought to receive the consent of the society.

MR. WELLS: I move then, that all dues of Mr. Watkins be remitted, and that Mr. Watkins be made an honorary member of this society.

Motion supported and carried.

MR. HODGMAN: I have a letter from Mr. Watkins. He expresses his extreme appreciation of the act of the board of directors—that he is grateful, but that if he ever can, he will pay all his dues.

THE PRESIDENT: Is there any further business?

PROF. DAVIS: There is a matter I wish to bring before the society as a director. I discovered that our former member, Mr. Mark, is some years in arrears in dues. I think I was the person who moved that his name take the usual course, made and provided in such cases.

I understand that Mr. Mark is in the room, and is willing to pay up his back dues and be reinstated, and I therefore make the motion, Mr. President, that Mr. Mark be reinstated, as a member in good standing in this society, whenever he pays his dues.

Motion supported and carried.

CONVENTION NOTES.

The convention was held in the council rooms in Jackson.

Jackson is a busy city and the busy people both inside and outside the building made so much noise that it was very difficult to hear the speakers in the convention, and much that was said the stenographer was unable to catch for that reason.

The Richmond & Backus Company of Detroit had an exhibit at the Hibbard House, of instruments manufactured by Keuffel & Esser Co., and which they have on sale. These are standard goods and nearly every member of the society uses more or less of them and as was to be expected the committee appointed to examine them (Messrs. Bailey and Albertson) spoke well of them, although no formal report was made and passed on by the convention.

Geo. F. Lucas of Castile, N. Y., had steel tapes and reels on exhibition. Mr. Rogers and others of the society who have Mr. Lucas tapes in use speak highly of their excellent quality.

Mr. M. H. Bailey spoke of an interesting case which had been tried in the circuit court of Eaton Co., relative to obstructions in a highway and illustrated it with a map of the premises and read the judge's charge to the jury in the case. The special point in the judge's charge was to the effect that no one but the highway commissioner has the right to remove fences from the highway and he only after the case has been prosecuted and tried in court.

The deaths of John O. Palmer, Joseph A. Watson, Isaac Teller and J. K. Yocum, were announced. The two latter had been active members in the society and the secretary is glad to be able to present brief sketches of their lives.

At the invitation of the authorities at the State Prison most of the members of the convention spent Thursday forenoon in viewing that institution.

The convention before adjourning expressed its sense of the courtesies shown them by a vote of thanks to the common council of the city of Jackson and to the members of the local committee.

At a special meeting the applications of the following persons were approved for membership by the board of directors:

FOR SENIOR MEMBERS.

P. A. COURTRIGHT, Surveyor,	Duck Lake, Mich.
J. B. FROST, Mechanical Engineer,	Jackson, Mich.
W. D. ELDER, Civil Engineer,	Kalamazoo, Mich.
F. TITTMAN, Civil Engineer,	Saginaw, E. S., Mich.
J. T. NELLIST, Surveyor,	Grand Rapids, Mich.

FOR JUNIOR MEMBERS.

W. L. CUMMINGS, Student,	Grand Rapids, Mich.
J. W. HARROD, Surveyor,	Ithaca, Mich.

These have since been elected members of the Society by letter ballot.

F. HODGMAN,
Secretary.

JOHN K. YOCUM

Was born at Dayton, Pa., March 27, 1819. He removed in early life with his parents to Livingston Co., N. Y., and in 1836 to Lyndon, Washtenaw Co., Mich., where he spent some years as farm hand and school teacher. On November 26, 1846 he was married to Maria A. Johnson and bought a farm in Lyndon upon which he lived until 1882 when he sold the farm and removed to Chelsea, Mich. He was elected a member of the State Legislature in 1849. He followed surveying and civil engineering for many years and kept up his interest in the profession until his last sickness. He was one of the early and reliable members of the Michigan Engineering Society and attended nearly all its meetings. He buried his wife in 1892, after which his own health failed and he died at the residence of his son M. F. Yocum in Jackson, Nov. 30, 1893. Thanksgiving day was an eventful one for him. He was married, moved from his farm, buried his wife and ended his earthly journey all on Thanksgiving day.

ISAAC M. TELLER

was born at East Springfield, Pa., Oct. 18, 1826 and died at his home in Cohoctah, Mich., of heart failure, Feb. 6, 1892. His early life was spent in Erie county, Pennsylvania where he passed a number of years in teaching and surveying. He moved onto a farm in Wisconsin in 1857 where he remained until 1863. He then enlisted in the engineers corps in the 8th Wisconsin Volunteers, and served till the close of the war, when he returned to Wisconsin. In 1868 he came to Cohoctah, Livingston Co., Mich. and purchased the farm on which he resided till his death. He was for eight years county surveyor of Livingston county. In 1883, Hon. H. M. Teller, Secretary of the Interior, appointed him Deputy U. S. Surveyor and he spent three years in the service as special agent of the department in Oregon and Nebraska. He was an active member of the Michigan Engineering Society and the wit and drollery with which he enlivened their meetings, especially when describing his adventures in Oregon and Nebraska, will never be forgotten by those members of the society who were so fortunate as to hear him on that occasion.

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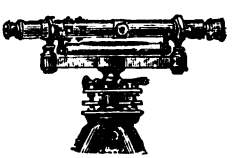

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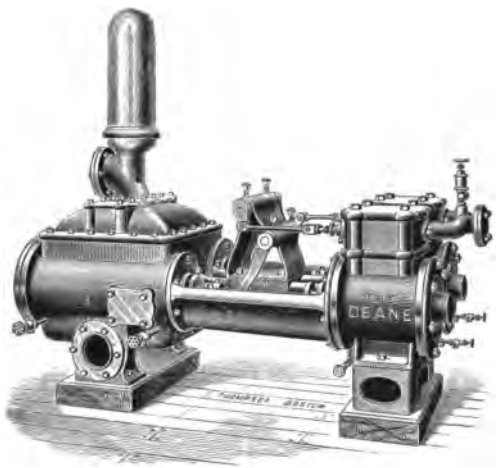

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